

C1850-2
4/16/87
JIA DOLLARD

Electronic Business

Spending trends for design automation systems

Connectors: Plugging into a \$4.6 billion market

P1372521 () 006/ 92

ACQUISITIONS EDITOR
CONGRESSIONAL INFO SRVC
SRI ACQUISITIONS
4520 EAST-WEST HWY
BETHESDA MD 20814



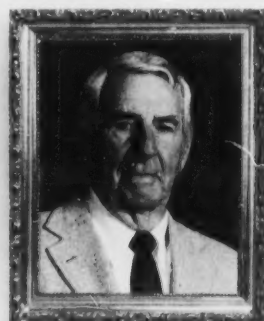
Canion
puter Corp.



Andrew S. Grove
Intel Corp.



Anthony R. Hamilton
Avnet Inc.

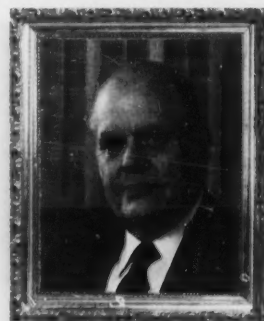


John H. Krehbiel Sr.
Molex Inc.



Scott G. McNealy
Sun Microsystems Inc.

The Best Executives of 1987



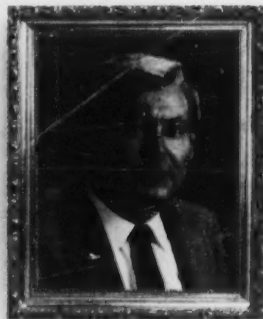
Kenneth H. Olsen
Digital Equipment Corp.



James E. Olson
AT&T Co.



Bernard L. Schwartz
Loral Corp.



Alan F. Shugart
Seagate Technology



John F. Welch Jr.
General Electric Co.

Electronic Business

VOL. 13, NO. 8

APRIL 15, 1987

THE BUSINESS MAGAZINE FOR THE ELECTRONICS INDUSTRY



PAGE 38

BUSINESS TRENDS

- 24 Is the U.S. too dependent on foreign semiconductors?**
The Defense Science Board is starting to question the use of Japanese chips in critical U.S. military equipment.
- 28 Defense electronics: Not the best of times, not the worst**
Although defense spending is expected to remain flat, electronics content of procurement continues to climb.
- 32 How Japan Inc. is cashing in on free U.S. R&D**
Technology transfer between federally funded labs and Japanese firms is flowing only one way — Eastward.
- 38 Marathon men: Using sports events to promote high tech**
U.S. electronics firms are turning to razzle-dazzle events for publicity.

FINANCE

- 82 What the weak dollar means to electronics**
As the dollar slides, U.S. goods become more attractive, and Japanese components get expensive.

PRODUCTIVITY

- 121 Design and engineering: Where the dollars are headed**
CAD systems were well received, and engineering applications are under-way. The managers control the funds.



PAGE 45

BEST EXECUTIVES

- 45 The Best Executives of 1987**
- 46 Desktop computers**
Joseph R. Canion:
PC strategist par excellence
- 47 Semiconductors**
Andrew S. Grove:
The semiconductor strategist
- 48 Distributors**
Anthony R. Hamilton:
The distribution decision maker
- 57 Components**
John H. Krehbiel Sr.:
Founder and patriarch
- 58 CAD/CAM/CAE**
Scott G. McNealy:
A workstation wizard
- 62 Computers**
Kenneth H. Olsen:
Minicomputer maven
- 66 Communications**
James E. Olson:
The information-age manager
- 70 Military**
Bernard L. Schwartz:
Defense dynamo
- 72 Peripherals**
Alan F. Shugart:
The peripherals potentate
- 77 Diversified electronics**
John F. Welch Jr.:
Transforming the old GE



PAGE 94

MANAGEMENT

- 94 Xidex: Masters of the media universe**
Rising to a \$600 million disk, tape and film empire was the easy bit. Staying on top might be tougher.
- 104 Building ICs on the edge of the Black Forest**
ITT is dismantling its international communications empire, but its micro-chip business thrives.

MARKETS

- 110 New challenges for U.S. connector makers**
Changing requirements in the computer and electronics industry are changing the connector business.

DEPARTMENTS

- 4 Inside Business**
- 9 Update**
- 17 Business Barometer**
- 136 Plant Sites: Defense drives**
Israel's electronics industry.
- 141 Quarterly Scorecard**
- 144 Calendar**
- 146 Editorial Index**
- 148 Viewpoint: Strategy for the last war.**

AN EDITORIAL INDEX OF ALL COMPANIES DISCUSSED IN THIS ISSUE CAN BE FOUND ON PAGE 146

Photo of frame/Martin Cooke

ELECTRONIC BUSINESS (ISSN 0163-8197) is published twenty-three times a year by Cahners Publishing, A Division of Reed Publishing USA, 275 Washington Street, Newton, MA 02158. William M. Platt, President; Terrence M. McDermott, Executive Vice President; Jerry D. Neth, Vice President of Publishing Operations; J.J. Walsh, Financial Vice President; Magazine Division; Thomas J. Dellamaria, Vice President Production & Manufacturing; Frank Sibley, Group Vice President. Copyright © 1987 by Reed Publishing USA, a division of Reed Holdings Inc.; Saul Goldwurtz, Chairman; Ronald G. Segel, President and Chief Executive Officer; Robert L. Krakoff, Executive Vice President. Advertising and editorial offices: Cahners Building, 275 Washington Street, Newton, MA 02158. Telephone: (617) 964-3030. Circulation offices: 270 St. Paul Street, Denver, CO 80206. Telephone: (303) 388-4511. Mailing list rentals: (312) 299-9311. Second class postage paid at Denver, CO 80202 and additional mailing offices. Postmaster: Send address changes to ELECTRONIC BUSINESS, 270 St. Paul Street, Denver, CO 80206. ELECTRONIC BUSINESS is circulated to managers of electronics companies. Subscription rates: U.S., Canada and Mexico \$50 per year; all other countries \$85 per year (including air freight), \$170 per year (air mail). Single copy rates: U.S. \$6.00, Canada and Mexico \$8.00, Foreign \$10.00. Cahners Publishing Company • A Division of Reed Publishing USA • Specialized Business Magazines for Building & Construction • Electronics & Computers • Foodservice • Manufacturing • Book Publishing & Libraries • Medical/Health Care

V BPA ABP

The communication equipment outlook starts to brighten

The situation, much improved in the first quarter, will strengthen as the business upturn takes hold

Although the fallout from deregulation continues to upset the communication industry applecart, the dust is beginning to settle. As a result, a number of markets are beginning to stabilize and equipment vendors can look forward to a more productive 1987, especially during the final two quarters.

After a relatively flat 1986 — plagued by end-user uncertainty and price wars that skewed a number of market segments — communication equipment vendors can expect a production ramp-up that will accelerate during 1987 and continue through the first half of 1988, according to Cahners Economics predictions.

The overall communications index is expected to rise 5% in 1987 — a much rosier outlook than the mere 0.7% increase that took place in 1986 — and then climb another 4% during the first two quarters of 1988 before tapering off the second half of next year.

Orders for communication equipment jumped 36% at the close of last year as military demand rebounded from a sluggish period in the fall. Despite that burst in activity, last year showed a loss of 0.4% to \$69.2 billion in production. This weakness in demand held back shipments throughout 1986 and resulted in a subpar performance for the year. However, Cahners' in-house economic forecasting unit suggests that backlogs this year will help prop the industry up, pushing up actual shipments by a modest 6.5%.

Meanwhile, overall U.S. industrial production is forecast to increase 6.2% this year and then slow to 2.2% during 1988, according to Cahners economists. This is due to the accelerating growth of the industrial activity, evidence of which is most visible in the apparent rebound in capital equipment markets.

On an even brighter note, shipments of telecommunication equipment are forecast to outpace production. That, at least, is the consensus among independent market research-

ers. According to estimates by research firm Dataquest Inc., a market research firm based in San Jose, Calif., U.S. shipments of telecommunication equipment are expected to grow from \$22.3 billion to \$24.8 billion during 1987, reflecting an increase of 11%.

One of the hottest ticket items for this year is equipment used in T-1 networks, which have the capacity to transmit digitized voice, data and video signals at speeds up to 1.544 megabits per second. The general consensus among industry analysts is that

the T-1 equipment market will grow at an average of at least 35% per year.

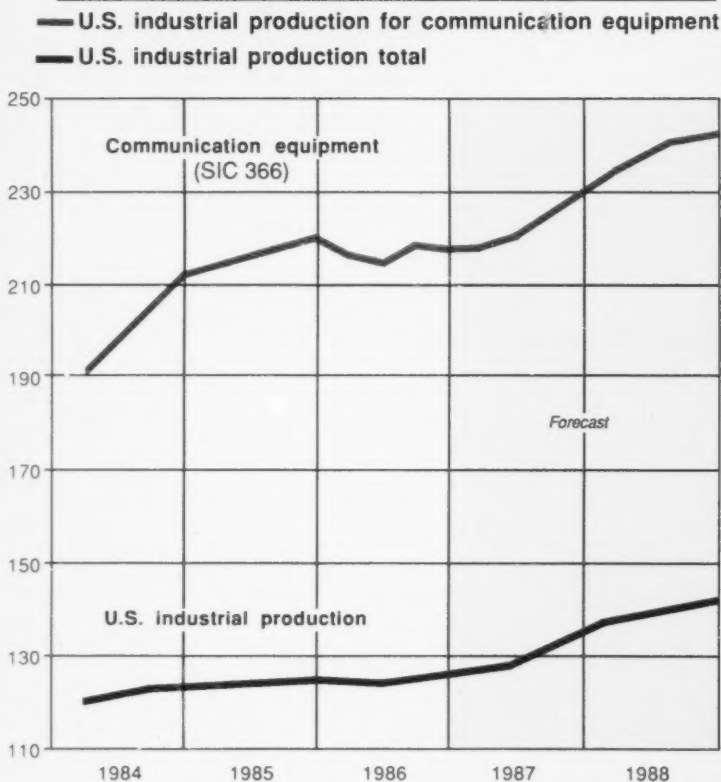
The electronics used in the building of fiber-optic telecommunication networks is yet another promising segment. Currently valued at \$875 million, this segment of the transmission equipment market is expected to hit \$1.026 billion by the final quarter of 1987, reflecting a hefty 17% growth rate, according to research firm Northern Business Information Inc.

Above all else, the proliferation of networks and the "network mania" that seems to permeate so many corporate offices today is having a positive effect on the datacommunications equipment market.

CAROL SUBY

Communication equipment

Industrial production indexes, 1977 = 100



Historical data: Federal Reserve Board
Forecast: Cahners Economics

Electronic components and accessories

Many categories of electronic components, including capacitors, connectors and some types of semiconductors, experienced mild upward price pressures in late 1986. This pushed industry-wide prices up 0.3% in the fourth quarter, to a level which was more than 2.7% above a year earlier. This compared with an increase of just 1% for the entire first half of the year. Prices should continue to push upward over the course of 1987 as the unfolding business recovery gains momentum. Following a modest overall increase of 1.8% in 1986, prices are expected to climb approximately 3.2% this year and 4.4% next year.

Capacitors

Capacitor prices, which had fallen for seven consecutive quarters, turned up in the fourth quarter of 1986, averaging 0.8% higher than they did in the previous quarter. Two factors were chiefly responsible for this reversal: a pickup in demand from the computer makers and recent changes in exchange rates. For example, the dollar's decline against the major European and Japanese currencies has caused imported aluminum foil to become more expensive, prompting some manufacturers to increase prices on electrolytic capacitors now that demand is increasing. There will be continued spot increases throughout 1987, pushing capacitor prices up 0.9% annually; that compares with a 2.5% decrease last year. A further rise of 3% is forecast for 1988.

Connectors

In the fourth quarter, connector manufacturers raised their prices by an average of 1.1%, about equal to the increases in the prior two quarters. This brought the overall 1986 price advance to 3.5%, the highest rate of market inflation in five years. Although demand will improve gradually throughout 1987 and the underlying rate of U.S. inflation will be rising, connector prices are expected to climb at a slightly slower 2.3% pace this year. The reason: price competition will stay intense between domestic and foreign suppliers while excess capacity remains unused. An increase of about 2.9% is expected next year.

Resistors

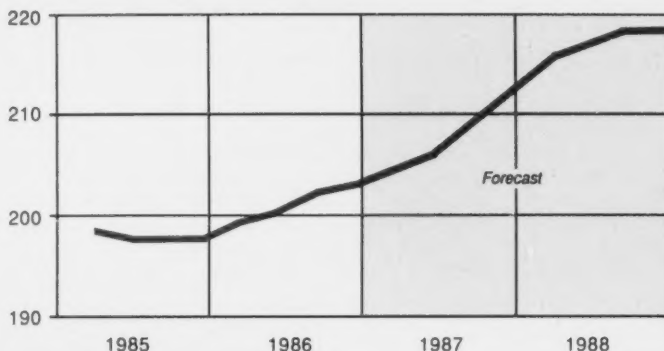
Resistor prices rose a modest 0.1% in last year's fourth quarter, bringing the overall 1986 increase to 1.9%. This represented a slight decline from the 2.7% rise posted in 1985. The recent turnaround in electronic end-equipment markets suggests that resistor manufacturers will see a slow but steady improvement in demand this year. However, the gains are expected to produce little change in prices. Prices are expected to edge up just 1.1% this year and about 0.5% in 1988.

Producer price indexes

Electronic components

December 1967 = 100, quarterly averages

— Electronic components and accessories (SIC #1178)



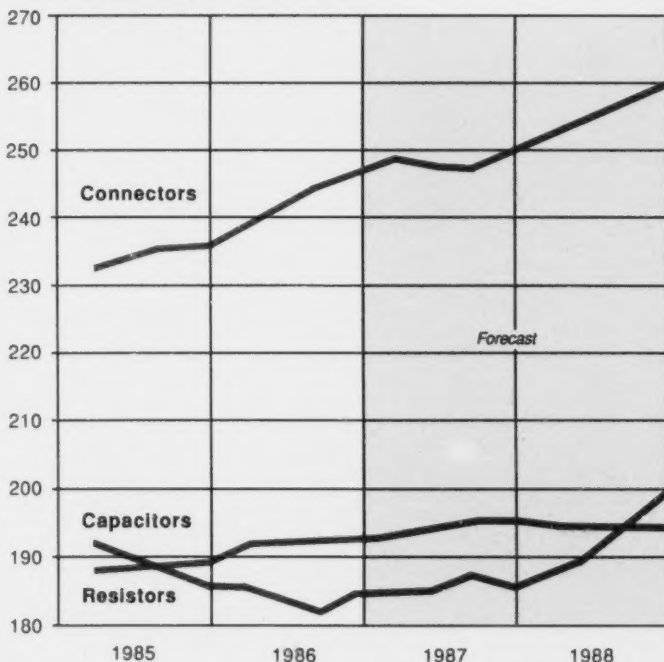
Passive components

December 1967 = 100, quarterly averages

— Connectors (SIC #1178-24)

— Capacitors (SIC #1178-11)

— Resistors (SIC #1178-12)



Historical data: Bureau of Labor Statistics
Forecast: Cahners Economics

New orders

Manufacturers of electrical machinery received \$52.2 billion in new orders in the fourth quarter of 1986, up from \$49.0 billion in the previous quarter. This sharp uptick in activity boosted annual volume to \$199.2 billion, an increase of 5.4%. Nearly half of the year's growth came from two segments: television and radios, where orders grew 17.5%; and electronic components, where there was a 7.9% rise in demand. The only area to lose ground in 1986 was communication equipment. Growth is expected to slow in defense and consumer-related segments this year, offsetting the improvements that are ahead for other electrical machinery markets.

Unfilled orders

Manufacturers' order backlogs continued to show little change in last year's fourth quarter; they averaged \$83.8 billion, a decrease of merely 0.3% compared with the third quarter. Annually, backlogs grew just 2.4%; this means that there was little actual growth, since the overall rate of U.S. inflation approached 2% for the year. Sluggishness in consumer and defense-related markets will prevent the overall electrical equipment industry from experiencing much backlog growth again this year; they are expected to increase just 4.2% this year, about on par with inflation.

Shipments

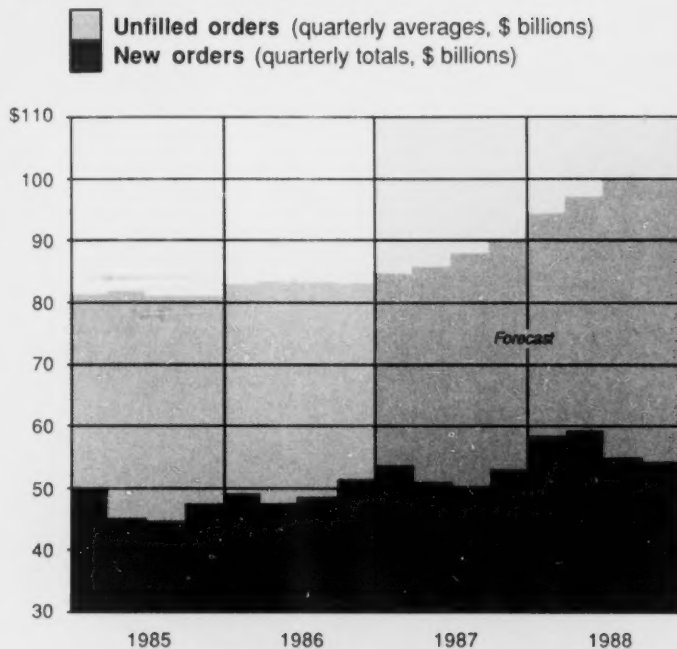
Electrical machinery manufacturers shipped an estimated \$52.7 billion worth of products in the fourth quarter, an increase of 6.7% over the previous quarter and 7.8% over the fourth quarter of 1985. This strong year-end performance lifted annual shipments up 6.3%. Growth was paced by consumer-related markets (such as appliances and televisions) and by the defense segment of the communications industry. These areas will experience more modest gains this year, but the effects will be counterbalanced by a gradual improvement in other electrical and electronic equipment areas. Shipments are expected to climb 3.5% in 1987 and a stronger 11.2% gain in 1988.

Inventory-to-shipment ratio

In last year's fourth quarter, total inventories (of raw materials, work-in-progress and finished goods) in the electrical machinery industry dipped 1.3%. Since shipment levels during the quarter rose briskly, the balance of manufacturers' inventories to shipments posted a sharp decline. The ratio averaged just 1.94 in the fourth quarter, down from 2.06 in the prior quarter and slightly below the level at the business cycle peak in early 1984. This suggests that inventories are now fairly lean relative to shipments. We expect manufacturers to maintain the current ratio for at least the next several quarters, keeping inventory growth in step with shipments growth.

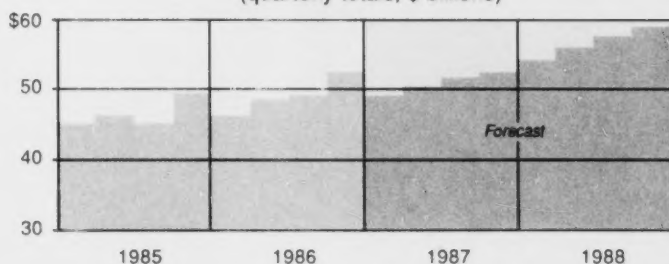
Electrical machinery

(SIC 36)



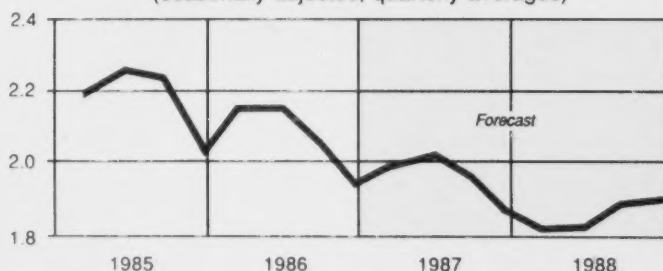
Electrical machinery: Shipments

(quarterly totals, \$ billions)



Electrical machinery: Inventory-to-shipment ratio

(seasonally adjusted, quarterly averages)



Historical data: U.S. Department of Commerce
 Forecast: Cahners Economics

Defense electronics: Not the best of times, but not the worst either

Defense spending is expected to remain flat, but the electronics content of procurement climbs

It's not the best of times for defense electronics companies. Pentagon spending is flat and the Democratic Congress is expected to keep a close watch on individual programs and future spending. Mergers and consolidations are restructuring the industry. Layoffs are rampant. And new contract regulations reportedly are eroding profits.

But for those companies that expect to survive the industry rationalization, it's not the worst of times either. "Despite inconsistencies, defense electronics remains a good business and a good place to be," says Bernard Schwartz, Loral Corp. chairman. Calling the current sluggishness just a "hiccup" in the procurement process, Schwartz expects current program stretch-outs to soon disappear as more compact and more efficient electronics systems replace old technology. "After the current shifting of gears," he says, "there will be sustained growth."

Schwartz is not alone in his optimism. Other defense electronics company executives and industry analysts have expressed similar views. In the face of a flat Defense Department budget, "defense electronics is still enjoying positive growth, both in absolute dollar terms and because electronics is growing as a proportion of overall defense systems," says Susan Pitts, an analyst with Alex. Brown & Sons Inc., the Baltimore-based investment banking company. "While the rate of growth is slowing, we feel most of the bad news about the industry" is under control, says Pitts.

Projections vary, but the Electronic Industries Association (EIA) predicts the electronics content of the Defense Department budget will grow about 8% over the next 10 years — from \$53.5 billion in fiscal 1987 to \$58 billion in fiscal 1996. The total defense budget, meanwhile, will increase only about 1% in the same period — from \$280 billion to \$283.9 billion.

EIA suggests the electronics portion of the budget — including procurement, original equipment and research, development, technology and engineering — will actually decline slightly over the next few years but then rebound.

Electronic components and systems — especially in the command, control, communications and intelligence (C³I) arena — are getting high priority as the services retrofit existing equipment. The emphasis is on reducing the size of electronic systems and increasing the commonality of components and subsystems. New technolo-

The drive for denser, more efficient electronic systems is causing problems for some contractors

gies like gallium arsenide (GaAs) and 32-bit microprocessors will help sustain the growth, according to Schwartz. And if the planned Strategic Defense Initiative survives despite some cynicism in certain quarters of Washington, it could mean big bucks for defense electronics companies. Not surprisingly, companies supplying those products concur.

New chip technologies

"Gallium arsenide has open-ended potential," says Ronald Rosenzweig, president and one of the founders of 2-year-old GaAs integrated circuit maker Anadigics Inc. of Warren, N.J. "It's very clear gallium arsenide is a technology the DOD views as extremely strategically important." The Department of Defense will fund development, he says, and be the driver for commercial applications, as well. Rosenzweig points to the planned five-year \$600 million Monolithic Millimeter and Microwave Integrated

Circuits (MIMIC) program to build gallium-arsenide devices keyed to specific military applications. Phase I MIMIC contracts were awarded in late January.

By 1990, he projects, the GaAs market will top \$1 billion. MIMIC is emulating the DOD's Very High Speed Integrated Circuits (VHSIC) program for very dense silicon chips. Although more expensive than conventional ICs, GaAs devices operate much faster than silicon devices and consume less power. They are also more resistant to nuclear radiation, making them well suited for military applications.

The drive for denser, more efficient electronic systems is causing problems for some contractors that are having trouble coming up with the required technology. "There are some sick mooses," says Donald Latham, assistant secretary of defense for command, control, communications and intelligence. It is necessary to learn from the difficulties experienced by problem programs if future efforts are to be a success, says Latham. For one thing, he says, there must be "more realism in initial specifications including software specifications."

Latham singles out such efforts as Hughes Aircraft Co.'s AMRAAM missile program and the Airborne Self-Protection Jammer (ASPJ) as problem programs. In the case of AMRAAM, Hughes must find a way to cram sophisticated electronics into a seven-inch diameter missile and at the same time accomplish multiple missions. Similar problems have cropped up with the joint Navy/Air Force program, ASPJ, which is two years behind schedule, according to Latham. The internal communications system must be small enough to fit into McDonnell Douglas Corp.'s F-18 and be diverse enough to also fit and work well in General Dynamic Corp.'s F-16. Prime contractors are ITT Corp. and Westinghouse Electric Corp.

As a result of technology problems on some defense programs, spotty profitability could hurt those companies trying to get back on track, says

Pitts of Alex. Brown. Programs to keep a close watch on, says Pitts, include Sanders Associates' INEWS, navigation electronic warfare system and TRW Inc.'s ICNIA, communications navigation system. "Uncertainty could be reduced if companies watch out for trouble programs," she says.

Scaling back

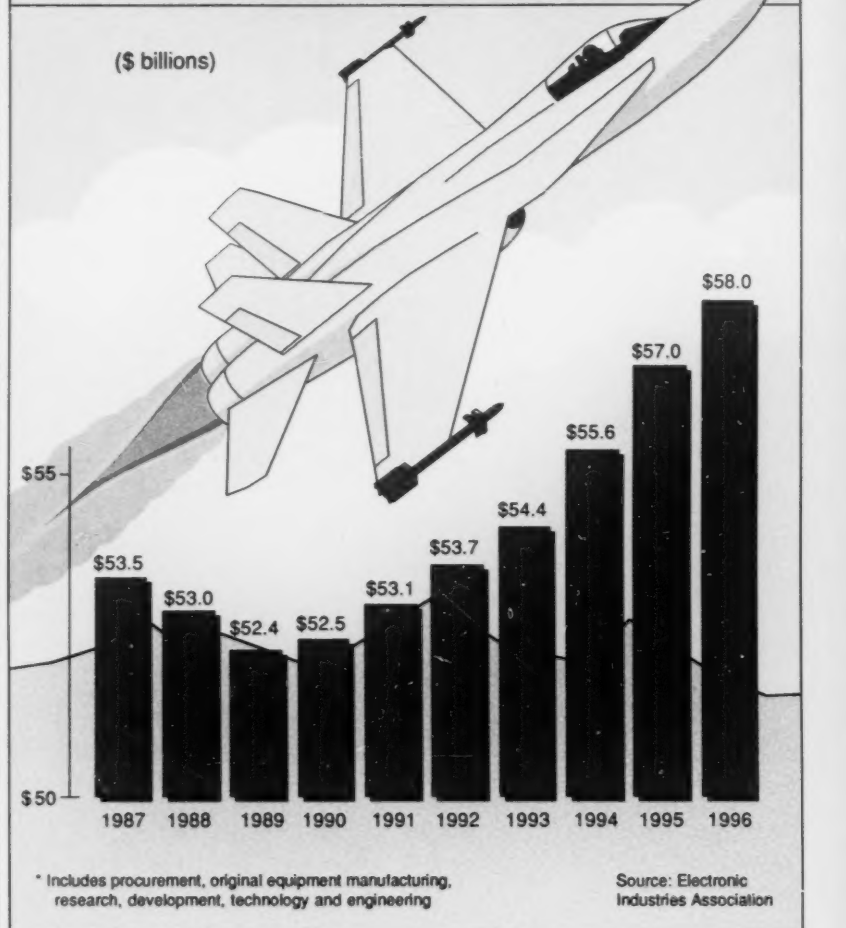
A number of contractors have cut back employment. Rockwell International, which wound down production of the B-1B bomber, laid off 6,800 last year. Honeywell Inc. is reducing its total corporate workforce by 4,000; Hughes Aircraft expects a layoff by the end of the year; and Northrop Corp., which canceled the F-20 fighter program for lack of interest, will reduce its workforce by 2,000 this year.

The defense electronics market and the fiber-optics segment of it are "lumpy," adds Albert Bender, president of Fibercom Inc., a manufacturer of fiber-optic communications, and data transmission products and systems. Bender expects a shakeout as companies merge and consolidate business. "There just may be too many companies chasing too little business," he says, although optimistic about his firm's potential business with the military. Fiber optics are well suited for defense applications, according to Bender, because of the small size and weight, immunity to nuclear blasts, increased security and long life.

Indeed, the defense industry consolidation has already begun. Loral, for example, acquired Goodyear Aerospace after pursuing Sanders, which eventually was purchased by Lockheed Corp. in August for \$1.2 billion. ITT created a new subsidiary, ITT Defense Corp., consolidating its defense and space divisions. Honeywell Inc. bought the Sperry Aerospace Group for about \$1 billion from Unisys Corp., the company formed by the merger of the Burroughs and Sperry corporations. General Electric Co., after buying RCA Corp., merged GE's Space Systems division with RCA's Astro-Electronics division. Also, GE's Military & Data Systems Reentry Systems business was combined with RCA's Automated Systems division to form the Federal & Electronic Systems Division.

Industry restructuring continues as the market evolves. "It's a changing and difficult defense contracting environment," says John Woodhull, president of Logicon Inc., the Torrance,

The electronics content of defense spending



Calif., defense software and professional services company. "But things are getting better now." For one thing, say Woodhull, the dust has settled following the 1985 Competition in Contracting Act. That law meant that sole source suppliers were no longer guaranteed follow-on business and had to spend considerably to bid on projects they had once been assured.

Also, according to Woodhull, the continuing pressures to cut down waste, fraud and abuse have resulted in more paperwork and confusion of accounting.

Despite the "hiccup" in market conditions or "difficult environment," depending on who you talk to, a number of companies are enthusiastic enough about the future of defense electronics to beef up their military operations. LNR Communications, for example, hopes the government portion of its business will increase from about 35% of revenue, in the

fiscal year ending this summer, to 50% in a few years.

"We want to take products that have found niche markets in the commercial world and find new markets in defense," says Sy Okwit, LNR president. In 1985, government-related business accounted for only 17% of the Hauppauge, N.Y., low noise reception, and communication equipment company. LNR makes solid-state communications receivers and transmitters and manufacturers certain key devices.

As Congress, the Pentagon and the White House continue to wrangle over defense spending levels, there are clear signs that electronics, at least, will continue to grow, albeit at a slower pace than in the past. "There is recognition from the top of the importance of C'I and in the budget from DOD and Congress," says assistant secretary of defense Latham.

BETH KARLIN

What the weak dollar means to electronics

As the dollar slides, U.S. goods become more attractive overseas, and Japanese components are getting more expensive

By Bruce C.P. Rayner

Since 1980, the U.S. trade balance in high-technology goods has been deteriorating at an alarming rate. In 1986, for the first time in recorded history, the high-tech trade balance turned red — import growth outstripped export growth to the tune of \$2.6 billion. The over-valued dollar and aggressive trade policies of some of America's trading partners have been partly to blame, but U.S. companies relocating offshore are also responsible.

Between 1981 and 1986, the U.S. current account balance (net trade of all goods and services) declined from a \$6.3 billion surplus to a estimated \$145 billion deficit. Most of that slide was due to the \$130 billion drop in the merchandise trade balance (net trade in nonmanufactured and manufactured output) that sank to a record \$170 billion deficit last year. While nonmanufactured trade in products such as oil and agriculture stayed more or less stable through this period, the manufactured goods trade balance went from a \$10.5 billion surplus in 1981 to a \$139.1 billion deficit in 1986, according to the Department of Commerce.

The American Electronics Association (AEA) reports that things are just as bad in electronics. According to Harry Lewenstein, manager of industry statistics at the AEA, the electronics trade deficit (including computers, telecommunications, components, consumer and medical electronics) for 1986 was \$13.1 billion. That figure has been falling since 1980 when it peaked at a \$7.4 billion surplus and has been in deficit since 1984. Also, Lewenstein says, the United States has had a persistent electronics deficit with Japan since the 1970s. In fact, the Japanese electronics trade deficit

has gone from \$3.7 billion in 1979 to \$20.4 billion in 1986.

Now that the dollar is settling down from its all-time high, set in February 1985, the high-tech trade balance is expected to show some signs of improvement. Some are forecasting it will turn back into a surplus again in 1987, but the signs of a turnaround are still vague.

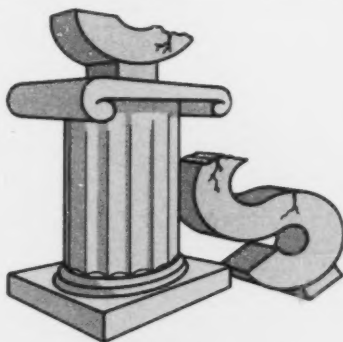
Economists estimate that the lag between the dollar's drop and an im-

and persistent economic uncertainty.

Many U.S. electronics companies are frustrated that their improved international competitive position is not translating into more foreign sales. Nonetheless, the mood is one of optimism for a pickup in 1987. Gerald J. Bojas, corporate controller at Compugraphic Corp. in Wilmington, Mass., expects the international market for electronic typesetting equipment to post stronger growth than the domestic market in 1987 because of the weaker dollar. Compugraphic, a \$340 million company, does about 30% of its business overseas, he says, mainly in Europe but also in the Far East and South America. The only positive sign so far, reports Bojas, is that foreign sales are "more steady" than domestic sales.

As for the strength of the domestic market, the lower dollar should theoretically crowd out more expensive foreign goods. Not so, says chief financial officer John Rogers of Zytex Corp., a \$50 million Minneapolis-based maker of power supplies. The Japanese, he says, are willing to keep prices competitive in order to preserve market share at the expense of profit margins. But some domestic manufacturers are starting to report some cracks in Japan's resolve as some cost increases are being passed along. But for other Far East competitors, many of whose currencies are tied to the U.S. dollar, their competitive position is not affected.

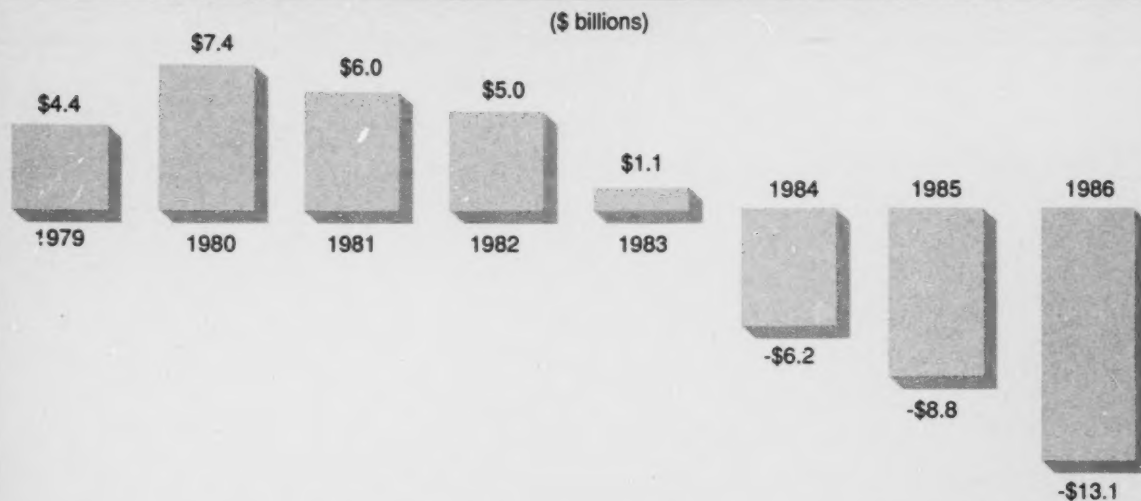
Although there has not been a flood of companies seeking repatriation in the United States, there is a noticeable trickle as a result of the rising yen. Earlier this year, for example, General Electric Co. of Fairfield, Conn., dropped Matsushita Electric Industrial Co. as a television supplier and began ramping up for big-screen tele-



The electronics trade deficit for 1986 was \$13.1 billion

proved trade balance is somewhere around 18 months. But it has been over 25 months since the dollar peaked and the trade balance is still far from healthy. Signs of improved exports, reopenings of onshore production facilities and a general reduction in the dependence on foreign-made goods have been slow to materialize. This indicates that other forces are at play in the marketplace — these include a still-s sluggish world demand for electronics equipment

The trade balance in U.S. electronics



Source: American Electronics Association

vision production in its Bloomington, Ind., facility. The reason for the move, GE said, was that Matsushita planned to pass on a price increase caused by the decline of the dollar.

For electronics companies that rely on Japanese components for their products, however, the dollar's drop is a mixed blessing. On the one hand, as the yen price of Japanese components starts to inch up, the price of U.S. products that rely on them also rise. But, at the same time, the dollar's decline is lowering the overseas price of U.S.-made products. As a result, some economists believe the U.S. trade balance has not budged because of the double-edged nature of exchange rates. Their suggestion is to let the dollar fall further.

For Termiflex Corp., a \$5.2 million company based in Merrimack, N.H., currency fluctuations are also a problem, says Lynn Friedel, vice president for finance and administration. The company does about 10% of its hand-held terminal business in Europe but so far has not seen any improvement as a result of a declining dollar. Friedel says Termiflex sources about 25% of its component parts from Japan but has so far not seen any significant price increases. The potential is there, she concedes, for the rising price of foreign inputs to counteract the gains from the falling dollar. Still, she expects European sales to begin to pick up soon and is looking to expand the company's overseas business to 20% of total sales.

The Japanese market is also appealing to many U.S. electronics companies, but it is difficult to crack. "Penetrating Japan is a bit like penetrating

the wall of China," says Kevin Walsh, controller of the Schlumberger Computer Aided Systems Group (CAS) of Schlumberger Ltd. "There are a whole series of other issues there that are not cost related."

Walsh says that in the European market, where Schlumberger is based, the competition from U.S. companies is getting tough. "We have people like Hewlett-Packard coming in and being very aggressive on pricing," he says. In response, Schlumberger's European operations have to rely on local increases in productivity to remain competitive.

Divining the dollar

The recapturing of market share depends on whether the dollar will stay down or start to rise again. Economists at the Bank of America (BOA) are confident that the lower valued

For some electronics companies, the dollar's drop is a mixed blessing

dollar will persist for the next few years with only minor ups and downs. But others believe the dollar will start to creep upward, maybe by the end of the year, and put a stop to the expected gains in U.S. exports.

The decline in the dollar "is a long-term adjustment to what was a long-term run up in the early 1980s," says BOA senior economist Jeanette Garretty. "Things are coming much closer in balance than what we have

seen in the last five years," she adds. Currency stability, however, will not benefit all business segments equally. High tech, says Garretty, will be the main winner. Other industry segments, including agriculture, petroleum and low technology, are not expected to recover in the near term. High tech, many argue, must play the phoenix and resurrect the trade imbalance through import substitution (replacing foreign goods with domestic goods) and export growth.

Because of the weakening dollar, BOA's World Information Services (WIS) is forecasting U.S. exports of high-technology products to more than double within the next 10 years. In 1987, the WIS U.S. Economic Report claims, exports of high-technology products will climb to around \$90 billion dollars, up from \$72.5 billion in 1986. To meet the growing demand, domestic output will have to rise by as much as 50% over the next 10 years.

But Howard Rosen, research associate at the Institute for International Studies in Washington, D.C., is not too impressed with the WIS forecast, considering the dismal growth high tech has posted in the last few years. "I hope it is a 50% increase," Rosen says. "If not, these [high-tech] guys are really in trouble."

Unlike Garretty, Rosen does not think the dollar drop is a long-term phenomenon. He believes it could start to climb by the end of the year as a result of growing demand for U.S. goods and climbing domestic interest rates brought about by the need for the U.S. to attract foreign capital.

Rosen is quick to point out that, although the dollar has fallen by over

40% in value compared with the Japanese yen and the German D-mark since early 1985, it has barely moved in relation to the currencies of Taiwan, South Korea, Singapore or Hong Kong — known as newly industrialized countries (NICs). Neither has it changed in relation to the Canadian dollar.

In 1985, over 20% of all U.S. high-tech exports, as defined by the Department of Commerce, went to these countries and they were the source of over 25% of America's high-tech imports. Asia's share of total U.S. trade has risen to 32%, up 11% since the mid-70s. In total, the NICs and Canada account for almost one-third of the U.S. merchandise trade. According to Lewenstein at the AEA, the electronics trade balance with Taiwan has gone from a \$2.5 billion deficit in 1985 to a \$2.9 billion deficit in 1986.

Robert Golden, vice president for finance at Mueller Electric Co., a \$5 million maker of electrical test clips and test leads, says he is seeing some improvement in his company's Canadian sales but is not sure whether it is a result of the dollar movement or the company's marketing strategy. About 10% of the Ohio-based company's sales are overseas, with most of that in the European market. Although Golden expects to see some improvement in the European market, there has been no improvement yet, he says.

When the dollar drops, NIC exports become that much more competitive with U.S. products for world market share. All of the major Japanese electronics multinationals have been capitalizing on the exchange-rate differential by shifting production to these

countries, and the United States has been doing the same. Japan, however, may have more to gain. Also, when the dollar was high in 1984 and 1985, U.S. high-tech exports became relatively more expensive to NICs and Canada in relation to European and Japanese goods. Canada's imports of high-tech goods from the United States declined by 3% between 1984 and 1985, and East Asian NIC coun-

tries dropped by 1.9%.

There are now some signs of slight movements between the NIC countries and the U.S. dollar, but nothing compared with what has happened with the European Economic Community's (EEC) currencies and the Japanese yen. The Taiwanese dollar dropped 10.5% in relation to the U.S. dollar between February 1985 and January 1987, while the European

1985 U.S. high-tech trade by region



Source: U.S. Department of Commerce

The U.S. balance in high-tech trade by segment

(\$ millions)

	1985			1986		
	Exports	Imports	Balance	Exports	Imports	Balance
Aircraft and parts	\$17,535	\$4,718	+\$12,817	\$18,435	\$5,781	+\$12,654
Communication equipment and electronic components	13,472	30,179	-16,707	14,873	33,495	-18,622
Engines, turbines and parts	3,127	2,980	+147	2,757	3,552	-795
Guided missiles and spacecraft	827	124	+703	664	168	+496
Office computing and accounting machines	15,421	10,901	+4,520	16,096	13,899	+2,197
Ordinance and accessories	714	255	+459	748	359	+389
Professional and scientific instruments	7,134	8,895	-1,761	7,816	10,735	-2,919

Source: U.S. Department of Commerce, Bureau of the Census

currencies dropped 40.1%, according to the Federal Reserve Bank of Atlanta's indexes. However, the Canadian dollar dropped only 3% over the same time period and the basket of Asian currencies, excluding Japan, slipped a meager 0.2%.

In order to improve the U.S. trade balance, economists argue, some NICs should revalue their currencies in relation to the U.S. dollar. If they do not, the United States could retaliate by hardening its own protectionist stance. For a country like Taiwan, that ships over 50% of its exports to the United States, keeping its currency overvalued would be economic suicide.

But Data Resources Inc. (DRI), senior economist Sara Johnson does not expect any quick moves by the NIC countries to realign. In the short term, she says, they will keep their currencies tied to the dollar and the United States will try to bring some pressure to raise the value of their currencies. Taiwan, because of its huge current-account surplus, estimated at around 20% of its GNP, is a likely candidate for a revaluation, Johnson says. But others, such as South Korea, with close to a \$50 billion foreign debt, might not be appropriate for currency adjustments.

A leveraged economy

Johnson expects the U.S. dollar to remain down for the medium term and expects America's high-tech trade balance to return to surplus in 1987. Total real imports to Korea are expected to grow by 21% while Taiwan's demand for foreign goods will grow by 16% this year, DRI forecasts. The U.S. share of this demand will "increase more than proportionately," Johnson says. Canada's imports, on the other hand, are only expected to grow at 4% in 1987 because of sluggish GNP growth. Similarly, DRI expects West Germany's imports to expand at a 9% clip; Japan's at 7%; Britain's at 7%; and Italy's at 10% for 1987. Most of these countries are showing GNP growth rates lower than the United States for 1987.

While high-tech might pull out of a deficit in 1987, the current account balance is not expected to come into the black anytime in this century, says Johnson. The reason is the highly leveraged U.S. economy — a runaway budget deficit and low levels of corporate and personal saving — coupled with sluggish world economic growth and developing country debt. Comments Johnson: "It is difficult to de-

termine whether or not [the trade deficit] is an insurmountable problem."

The trade and budget deficits are severe but, because the United States has never been in such a position before, it is unclear just how severe. Rosen warns that the United States must start producing budget surpluses by the 1990s in order to pay off its debt, but he sees little chance of this actually happening. "I don't even think this is a long-term turn around in the dollar," he warns.

BOA's Garretty agrees that surpluses are needed and that to ignore the deficit problems will only create

Companies are becoming more adept at operating in the global arena

serious problems down the road. But BOA is forecasting that manufactured goods trade balance could improve by as much as \$200 billion within 10 years, which would put that segment of the current account into surplus. But the problem lies with the growth of the nonmanufactured goods deficit and the services deficit, which included the cost of servicing the grow-

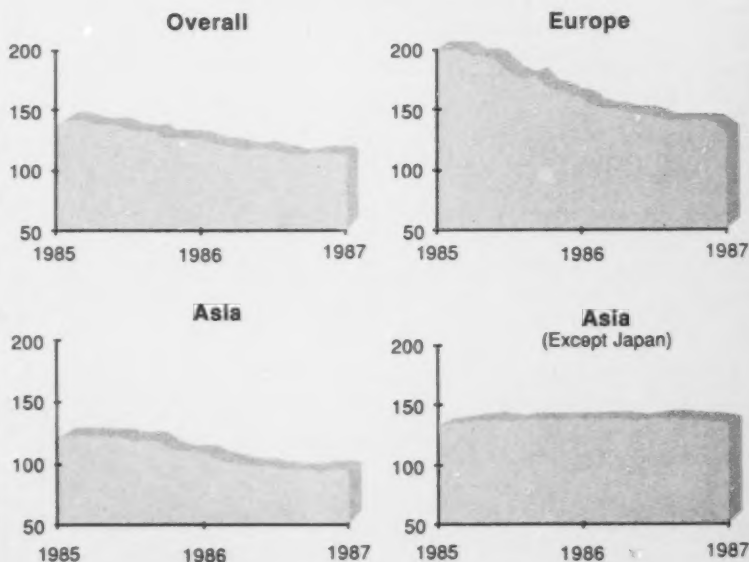
ing foreign debt.

As for the competitive position of U.S. firms, especially high-tech companies, it is difficult to determine if shifts in market share are caused by structural change in the global market or by changes in exchange rates. More and more, economists argue, it is wrong to focus on a country's trade balance to gauge the health of its industry. With the blossoming of joint ventures, foreign subsidiaries and marketing agreements, companies are becoming less dependent on the health of their country of origin and more adept at operating in the global arena.

Economists Robert Lipsey and Irving Kravis have found that the worldwide market share of U.S. multinational corporations has not changed significantly since 1966, despite the decline in U.S. market share. These companies, they argue, are not dependent on international price differentials for their well-being. Instead, they shift production to the most economical market to ensure they stay competitive. As more companies strike international poses, the health of the U.S. trade balance will come to be less significant to the health of individual corporations. □

The decline of the dollar

(Index: 1980 = 100)



Source: Federal Reserve Bank of Atlanta

New challenges for U.S. connector makers

Changing requirements in the computer and electronics industry are changing the way connector makers do business

By Mike Leibowitz

In an age where almost every industry is striving to become more market driven there is one industry — connectors — that wishes it could become less so. During its 40-year history, the U.S. connector industry never had a choice in the matter. A quintessential market-driven business, the sole purpose of connectors is to accommodate the changing requirements of electronic circuitry and systems.

But whereas the U.S. connector industry rode a powerful wave of growth in electronic equipment manufacturing — allowing it to swell at a rate of 20% to 30% annually during the 1970s — today, the wave is gone. Instead, the U.S. equipment market is dictating a new, harsh market reality to connector vendors. And, in true tradition, the connector industry is adapting to it.

The past two years have been particularly difficult ones for the \$4.62 billion U.S. connector industry. After suddenly dropping 8.1% in 1985, a small level of growth — 4.5% — has returned to the U.S. connector industry in 1986, according to Fleck Tele-

The U.S. equipment market is dictating a new, harsh reality to connector vendors

sis, a Huntington Beach, Calif., connector market analysis firm. But the gloomy news is that the present situation is not expected to get much better.

"I do not believe we'll ever see the heyday of 25% and 30% expansions ever again," says Fleck Telesis' presi-

dent, Kenneth A. Fleck. During the next five years, Fleck projects a mere 5.5% average annual growth rate for the U.S. connector industry. According to Fleck, the connector industry must reconcile itself to a future of low growth levels.

Others in the industry are a little more optimistic. While agreeing the heyday has past, Richard Evans, marketing operations director for Minnesota Mining and Manufacturing (3M) Co.'s Electronic Products Division, says that a more reasonable average growth projection is 8% to 10% annually through 1991. "I'm not in the doom and gloom camp," says Evans.

Vendors and analysts give a couple of reasons for the low growth projections. Some of the blame is placed on the industry's overcapacity and a temporary slowdown in the production of certain end products such as computers, which the connector industry re-

U.S. connector market

Factory shipments of connectors, IC sockets and backplanes (\$ billions)

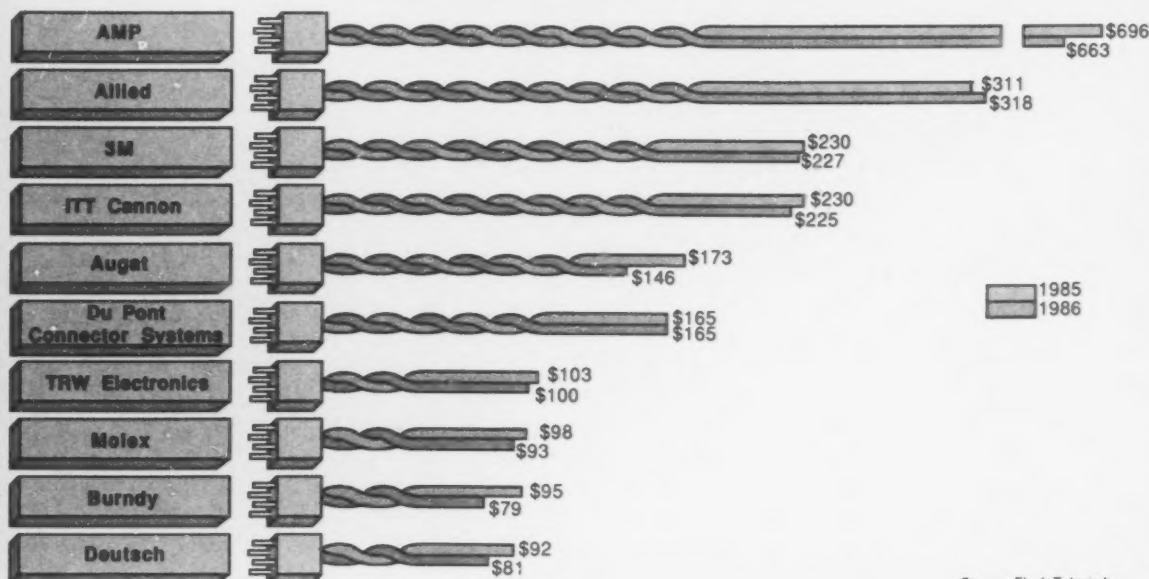


Does not include captive production

Source: Fleck Telesis Inc.

Top U.S. connector makers

U.S. factory shipments (\$ millions)



Source: Fleck Telesis Inc.

lied on for much of its growth during the 1970s.

But, far more catastrophic, many believe, are the permanent market losses occurring from the exodus of U.S. manufacturing overseas. This exodus is a result of foreign equipment manufacturers taking market share from U.S. original equipment manufacturers (OEMs) and from American firms moving their manufacturing offshore. Those firms assembling overseas might initially continue buying from U.S. vendors, says William Nuckols, vice president of Burndy Corp., but they ultimately switch to local sources. "To the extent that production of the end product is overseas, a net loss [occurs] to the U.S. connector market."

Foreign competition

Many also cite a relatively new phenomena in the U.S. connector market: competition from foreign connector firms. Virtually nonexistent five years ago, the presence of Far Eastern connector vendors has increased to capture 5.7% of U.S. connector sales in 1986, according to Fleck Telesis. Besides taking market share, these foreign vendors have severely depressed prices for a number of commodity connectors. "The only thing the Japanese or Taiwanese have to offer is a

cheaper price," says analyst Fleck.

A case in point is the popular D subminiature connector which is used on terminals and personal computers. The connector sold for over \$1 three years ago, but last year, Far Eastern firms bid the price down to 20 cents. U.S. firms managed to keep 90% of the D-subminiature connector busi-

Some connector vendors have responded to the new market conditions by following the business as it moves offshore

ness, according to Fleck, but only by matching the 20 cent prices and forsaking profits. Fleck predicts that over the next five years foreign connector firms will continue their efforts to buy into the U.S. market, doubling their overall stake in the U.S. connector market to 10.8% by 1991.

Some connector vendors have responded to the new market conditions by following the business as it moves offshore. In the past five years, five U.S. companies out of the top 10 have opened new plants overseas, and

today, 11 of the top 20 U.S. connector firms have foreign manufacturing operations. Recently, many of these firms have seen very strong growth, partly due to a decrease in the value of the dollar versus other currencies. AMP Inc., for example, saw a 36% increase in its foreign sales during 1986, while Molex Inc. saw their foreign sales rise 27%. Both AMP and Molex now make at least 50% of their sales in overseas markets.

But the most fundamental response to the market slowdown is an industry-wide consolidation. Vendors are merging with, and acquiring, other connector firms in order to pool resources, broaden product portfolios, and move into fast growth segments. According to analyst Fleck, six out of the industry's top 20 firms were involved in a merger or acquisition in the past five years. "The big will get bigger and the strong will get stronger," says Fleck. In the future, "a lot of firms will still be in existence, but they will be under one identity."

3M, for example, acquired six small specialty connector manufacturers during 1986, increasing their participation in fast-growing product areas. The acquisition of Chabin Corp. now makes 3M a supplier of high-frequency transmission line assemblies, which 3M expects will grow at a rate

of 10% to 12% a year. Its acquisition of Symbex Corp. puts 3M in the business of molded cable assemblies, another high growth area. Dorrans-Photonics, which 3M also acquired in 1986 gives the company its first fiber-optic product line. "[The acquisitions] either give us a broader product line in an area we were already in, or they take us in a completely brand new direction," says 3M's Evans.

Acquisitions very clearly will continue as a growth strategy for 3M. Evans says that it is "one of the ways that 3M can get back to healthy double-digit growth." He expects 3M to average 12% to 15% annual growth in connectors over the next five years.

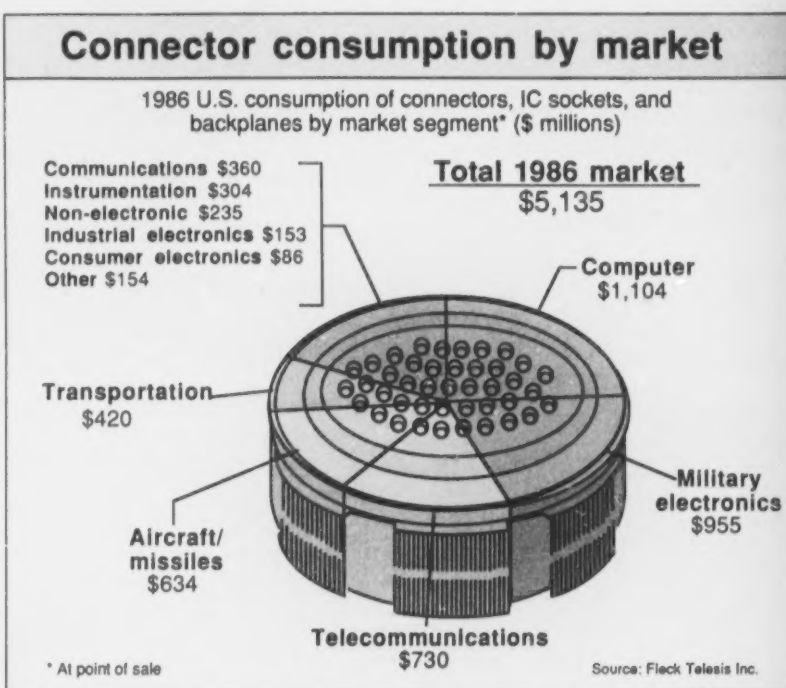
While the strategy for many major firms is to further entrench themselves through acquisitions, others are pulling out of the business. Allied-Signal Inc., a \$11.8 billion conglomerate, has now put up for sale the four companies that it acquired to become the second largest connector supplier: Amphenol, Bendix, SpectraStrip and Underwriter Safety Devices. Comments one vendor, who did not wish to be identified: "This should tell you something of how some companies view the connector business."

Choosy OEMs

Companies that remain in the connector business are further encouraged to consolidate due to many customers' desire to deal with fewer vendors. OEMs are reducing the number of connector vendors they do business with; and keeping only those that provide the broadest lines, highest quality and best delivery performance. "Instead of having 15 or 20 [connector vendors], they are, right now, paring down to five or six, and eventually will pare down to three or four," says Kerry Krafthefer, Molex's Datacom Division president.

For example, since 1983, Apple Computer Inc. has terminated business with one-third of its connector vendors. Consequently, Apple finds that they receive better service from those remaining vendors. "Instead of taking leverage and spreading it across multiple vendors we take that leverage and apply it to a few," says James Bilodeau, Apple's materials manager.

At Hewlett-Packard Co., Daniel A. Bechtel, director of corporate materials, says that HP is actively cutting connector vendors while attempting to reduce the number of different connector types in use. "Our goal is deal with probably two, maybe three [vendors] for any one major series of con-



nectors." About vendors that stay on his list, Bechtel says: "They've got to perform. Basically, they've got to perform."

Consequently, connector manufacturers now voice a commitment to service with a born-again fervor. "Our industry has had a horrible, horrible reputation over the years for service,"

The key strategy to improving service is to improve manufacturing, vendors say

says Fuller Atkinson, vice president and general manager of TRW Inc.'s Connector Components Division. "We had a tendency to get away from very basic principles. Our job is to service our customers and I think we lost sight of that."

Improving quality

The key strategy to improving service is to improve manufacturing. Many vendors have installed statistical process control (SPC) systems which tightly monitor and control the manufacturing process from beginning to end, improving quality, reducing scrap, and assuring a continuous flow of product off the line. SPC lowers the number of defective parts

reaching customers and reduces the likelihood of missed delivery commitments.

Virtually all of the top 20 vendors today offer just-in-time (JIT) service to some major customers; and most vendors expect to expand their JIT capabilities through 1987. Being able to deliver parts for just-in-time manufacturing does not only benefit JIT customers, vendors say, but JIT improves the overall ability to produce quality products on time; the benefits of JIT spill over into the entire customer base.

Major customers have seen a difference in the service level of connector manufacturers. "They have better deliveries, shorter leadtimes, and their quality has improved," says Hewlett-Packard's Bechtel. "We're seeing progress." Apple's Bilodeau agrees, "Those vendors that we now are dealing with give us better quality and much better service than they did five years ago. They cater to our needs a lot better."

But other customers are waiting for more improvement. James Noll, director for material at Northrop Corp.'s Defense Systems Division says that although the quality of connectors from his 11 vendors has improved, large connector vendors still lack the flexibility to provide "specials," or slightly modified standard products, in a hurry. His division pur-

chased \$3.5 million in connectors last year, but Noll reports, "They are still a pretty independent group of people — the [long] leadtimes pretty well stick."

William Phipps, who supervises the procurement of approximately \$750,000 in commercial and military-grade connectors for E-Systems Inc., still suffers from connector manufacturers' missed delivery promises. "Just finding somebody that delivers when they say is tough," he explains. Phipps says that getting reliable connector deliveries is harder than for most other products. "Someone who lives by their contractual commitments — that's rare in the connector industry."

Connector manufacturers say industrial distribution has become more important to them as a way of providing good service to many smaller accounts. Distribution is now 26.7% of the U.S. connector business, from 18% 10 years ago, according to Fleck Telesis. But distributors complain that despite fancy talk, connector manufacturers often do not provide them with the necessary level of technical sales assistance to do their job.

Role of distribution

"Few vendors truly understand the role of the distributor," says Kenneth Block, vice president for marketing/product marketing of No. 1 connector distributor, Time Electronics, a division of Avnet Inc. According to Block,

Many manufacturers form partnerships with major customers to develop leading-edge connectors

some vendors view distributors as "customers" and expect them to do all the sales work alone. This, he argues, is wrong. "We are a partner."

Block says that for the most part, vendors that are financially healthy are either increasing their support or continuing reasonable distribution support levels. The less prosperous suppliers, however, have reduced their support. "While they may preach the importance of distribution, they are in survival mode."

Although the market for connectors has slowed, electronics technology has not. Instead, advances have created a precipitous need for new types of connectors and surface mount versions of

existing connectors. Unfortunately, this calls for considerable expenditures for product development and tooling at a time when connector vendors can least afford it.

High-density and high pin-count packages require vendors to develop equipment for manufacturing at far tighter tolerances than before. They also require experimenting with new materials that can withstand the stresses of surface mounting without the slightest distortion. And with rising signal frequencies of electronic circuitry and systems, the design of the contact becomes critical. Connector designers must avoid even slight contact discontinuities that could create circuit problems from the reflection of signals.

"For new technology, it's not just a matter of developing a new metal-bashing tool," says Nicholas Pearne, the director of BPA Ltd., a packaging and integration consulting firm of Cold Springs Harbor, N.Y. "You really need a fundamentally different approach."

Firms have targeted the fastest growing market areas as the ones in which to commit internal product development resources. The industry leader, AMP, is focusing its efforts on developing connectors for local area networks, fiber-optic connectors and high-density connectors. Augat Inc. is emphasizing connectors for the automotive and telecommunications markets. TRW is concentrating on developing high-density sockets for next-generation IC packages.

But the rate at which many new products emerge is likely to disappoint customers which already complained that the development of new connectors lags the rest of the electronics industry. The problem in leading-edge connector development is an uncertain return on investment. Vendors now realize that tooling up for leading-edge connectors in advance of demand is "a very risky strategy to follow," according to packaging consultant Pearne. Connector manufacturers, unlike semiconductor makers, typically have little ability to predict which connectors will become widely accepted. This makes it virtually impossible for them to gauge which products they should develop for a future market. For example, "a lot of them made a commitment to JEDEC J-leaded packages," says Pearne. "They are now wondering whether those will ever be of any use to anyone."

Indeed, many manufacturers fre-

quently form partnerships with major customers to develop leading-edge connectors. This does two things: it guarantees that the vendor will see at least nominal business for the product, and it gives the product a head start toward becoming an industry standard. The burden for creating advanced connectors therefore falls on the customer. "Who's been sorting out IBM's problems for high pin-count zero-insertion force connectors?" asks Pearne. "The answer is: IBM. Where did DIN connectors come from? Siemens — because they needed them. It tends to be the OEM, who eventually says, 'I'm going to

Connector makers are waiting for their customers to make a commitment to surface mount technology

realize the benefit of this, I'll make it happen." Pearne says it will be the systems houses that propel new product development. "It has got to be the customer that says what he needs."

The same problem applies to surface mount connectors. "Connectors are one of the last components to get [vendor] attention from the surface mount standpoint," says 3M's Evans. One reason, says Evans, is the considerable effort required to develop a connector that "people grab ahold of, pull on and push against, and wiggle." Another reason, is that vendors are waiting for customers to make a commitment to the technology. Today, 5% or less of all printed circuit boards are surface mounted, says James Marley, president of AMP.

3M illustrates the problem many vendors face in developing surface mount products. They have developed internal capability to design and build surface mount connectors and have sampled 25 customers, but they are working with only six customers so far, according to 3M's Evans. In the meantime, 3M has introduced a surface-mount compatible product line that utilizes a through-hole pin with a solder doughnut on it. This interim step allows the part to be soldered at the same time as the other components. But as for their long-term surface mount product plans, "We're looking for OEMs so that we can continue developing [surface mount] products for the market," says Evans. □

Design and engineering: Where the dollars are headed

CAD systems and engineering applications are underway. The managers control the funds

The automation of the electronic design and engineering process is receiving tremendous investment and attention. The addition of the engineering workstation to the engineering activity has transformed the entire computer-aided design and engineering (CAD/CAE) environment.

The workstation and accompanying software and peripherals have meant that electronics executives are faced with capital investment decisions that are vital to a company's strategic future. In order to understand the current attitudes toward the design and engineering process, ELECTRONIC BUSINESS in conjunction with Coopers & Lybrand undertook a sweeping survey of the design and engineering universe. The results of the survey are contained in the following special report. The report includes the survey's results along with an accompanying analysis by Coopers & Lybrand.

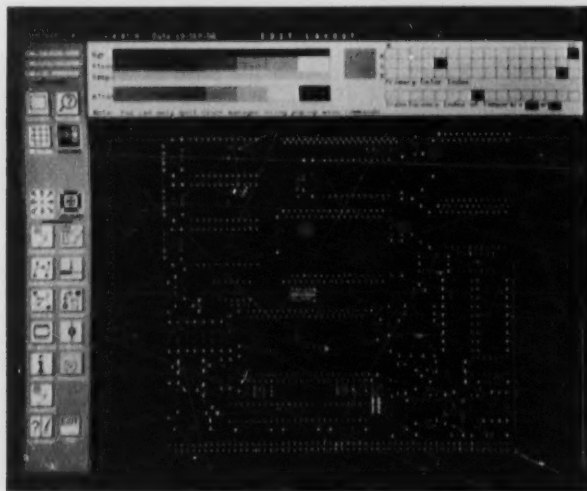
The survey was mailed

out to 1,500 presidents, vice presidents and chairmen, and to 1,500 vice presidents for engineering, directors of engineering, engineering managers and chief engineers from ELECTRONIC BUSINESS' circulation list. We received 230 responses, with 100 letters returned to sender, that left us with an 8% response rate. The answers that we compiled from these responses have a 95% confidence level of accuracy to $\pm 3\%$.

ERIC LUNDQUIST

**Coopers
& Lybrand**

**Electronic
Business**



Photograph: Henry Hillard/Picture Group. Screen: Computervision Corp.

Design automation: A strategic necessity

Most electronics and computer companies are automating their design process. But chief executives must become more involved



Irvin Krause

Krause is the National Director of Computer Integrated Manufacturing at Coopers & Lybrand.



Cheryl R. Suchors

Suchors is the director of the National High Technology Industries Group at Coopers & Lybrand.

By Irvin Krause and Cheryl R. Suchors

The need for electronics companies to move new products into the market faster grows more urgent daily. At the same time, the majority of the cost content of a quality electronics product is determined by its design. Companies whose design and engineering departments do not use computers effectively or whose departments are not properly integrated into the manufacturing and marketing operations as part of an overall computer integrated manufacturing (CIM) process will not be able to compete in the global marketplace.

Most electronics companies have begun to automate the design and engineering function — but they are strolling rather than sprinting toward full automation. Despite the fact that strategic planning and major capital investments are involved, chief executives are not yet taking the initiative they should to implement CIM on a company-wide basis; many executives are untutored in this area of automation. Unless executives guide the process of automation within their companies, each department will purchase equipment that meets only its own needs. Isolated pockets of automation will result and the company will forfeit the strategic momentum a CIM environment can provide.

Surprisingly, smaller companies, perhaps because of their greater vulnerability to competitive actions, have moved into this area of CIM more aggressively and with more chief executive initiative-taking than larger electronics firms.

Adding to the slow penetration of CIM in design and engineering is the fact that the traditional measure of return on investment (ROI) is one of the hardest to use to justify the expense of automation. Most of the investments in automating design and engineering departments in companies of all sizes have been made in the labor-intensive areas of artwork preparation and schematic capture. The chief benefit in these areas is savings in direct labor costs.

Automation of design rules, for example, means fewer engineering changes once the product is released to manufacturing. The manufacturing operation runs more smoothly and efficiently and the product gets to market sooner. Although major strategic benefits are realized, these results are harder both to measure and attribute to the automation of the design and engineering department.

We expect to see continued corporate investment and greater penetration of CIM into the labor-intensive aspects of the design and engineering process. We believe companies will also broaden the usage of workstations to engineering applications, such as design rules, as companies better learn how to quantify the strategic importance of CIM to this function.

However, for electronics firms to win in the race to worldwide markets, they will have to take longer and more far-reaching strides in automation. Companies will need to operate on a project management basis enabling the design, manufacturing, and marketing functions to operate simultaneously rather than in sequence, as they do now.

Projects carried out in this kind of work environment could cut product leadtimes dramatically. The project-oriented environment requires various departments in the organization to supply and to share information accurately and within the times required by project management systems. Designers will require cost and projected cost information from the manufacturing or financial departments. Designers, in turn, must supply production and marketing personnel with staged partial designs in addition to completed designs. Such high-level integration can occur only where the design and engineering department is automated and where there is company-wide implementation of CIM.

Engineers will continue to press for automated tools to improve the quality and ease of their work. Only top management can ensure that the automation of the design and engineering department enhances productivity throughout the firm.

Every survey respondent with more than

\$50 million in revenue has indeed begun to automate the design and engineering function. Almost all (90%) of the companies between \$20 million and \$50 million in sales are also using computers for design work.

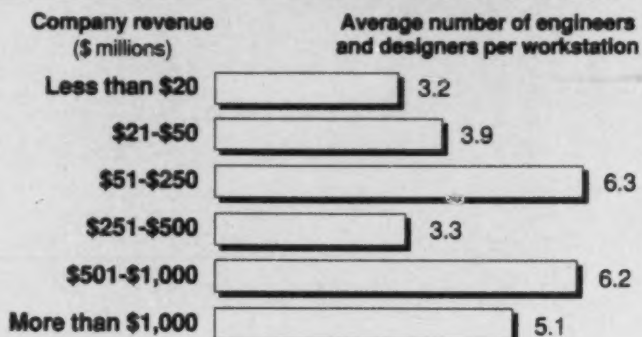
Companies under \$20 million in sales report that 38% have yet to buy their first workstation. Even so, the clear majority of even the smallest companies in the survey have already taken some steps on the road to CIM.

These impressive penetration percentages conjure up images of equally impressive investment figures. Yet only a small portion of the companies have invested more than \$500,000 in any one area of the design process. Even though you might expect that most billion-dollar electronics firms would spend over a million dollars in 1987 in a number of areas of the design process, this is not the case.

Despite lower capital investments in equipment, the smallest companies are further ahead in terms of penetration of automation into the design and engineering function. The largest companies in the survey reported that they own one workstation for every five to six engineers. The smallest companies have significantly fewer engineers sharing equipment — three to four per workstation.

Even though less absolute investment is

Penetration of CIM into design and engineering departments



required for the smaller engineering and design departments of companies with less than \$20 million in sales, these results are surprising. Smaller companies may well be using equipment availability to help attract and retain the engineering talent they need to compete against the deeper pockets and broader resources of larger competitors.

One explanation behind low investment levels in general is that chief executives are

What has automating the design and engineering process accomplished?

	Size of company (\$ millions)					
	Less than \$20	\$20 - \$50	\$51 - \$250	\$251 - \$500	\$501 - \$1,000	More than \$1,000
Achieved faster time to market	68%	61%	50%	82%	88%	80%
Met ROI expectation	53%	45%	53%	43%	43%	56%
Improved design productivity	78%	68%	67%	100%	88%	88%
Improved manufacturing quality	65%	65%	76%	56%	100%	79%

How do electronics companies justify automating the design process?

	Most important justification	Second most important justification	Third most important justification	Total respondents marking each category
Faster time to market	14.7%	11.4%	3.9%	30%
Traditional return on investment	10.9%	4.2%	5.9%	21%
Improved manufacturing quality	6.0%	11.0%	8.0%	25%
Can't design product without it	3.9%	2.8%	2.3%	9%
Shortage of designers	3.4%	3.4%	5.2%	12%
Other	2.1%	0.3%	0.6%	3%

COMPUTER INTEGRATED MANUFACTURING

Only top management can ensure that the automation of the design and engineering department enhances productivity throughout the firm

not initiating it. The initiative for automating the design process in replying companies of all sizes is coming primarily from the engineering department itself — not from senior management or from a company-wide plan to implement CIM. This was the case with the initial computerization of materials management and financial systems.

Only in the smallest companies does the chief executive or president take the initiative. And the push to automate is implemented through a formal CIM plan only in the second smallest grouping of companies, those between \$20 million and \$50 million in sales, not in the larger companies more frequently associated with the rigors of formal planning. In larger companies, the second most influential source spurring investment in automation of design and engineering comes from outside of the company — competition.

Although the presidents do not usually initiate the purchase of workstations, they do control the system's purchase. Fifty-one percent of the responding companies reported that the president or chief executive had to approve the decision to automate. Senior executives, in all of the companies except those with over \$1 billion in revenue, were involved in automating their engineering and design departments — but at the end of the process rather than the beginning. Top management seems to be more reactive than proactive toward the process of automation.

The largest companies in the survey are certain that they are doing at least as well or better than their competitors in automating the design process. Only 12% of the companies worth between \$500 million and \$1 billion thought that they were behind the competition; none of the companies worth over \$1 billion thought so.

In comparison, 42% of the companies worth under \$20 million believed that they lagged the competition in automation. More

than a third of those worth between \$20 million and \$50 million felt the same. This perception may well be the driving force behind these groups' executive-level initiatives toward automation and the resulting higher penetration levels. Smaller companies are, in fact, beating their larger competitors in providing their engineers with better access to equipment.

Are managers satisfied?

Ninety percent of the respondents to our survey on automating the design and engineering function said they would do it again.

Across the board, management of electronics companies cited "faster time to market" as the most important reason for justifying the purchase of workstations and other equipment. The second most important reason was the traditional ROI ratio.

Most respondents were confident that automation had shortened their time to market, especially in the companies having over \$250 million in sales. The majority had also improved their design productivity and their manufacturing quality, key factors to successful operations and both rated highly as reasons to automate.

Automation's ability to meet ROI projections turned out to be closer to a 50-50 proposition. And, even though ROI analyses are appropriate to gauge the importance of an automation investment, the analyses are only as good as the cost/benefit data used.

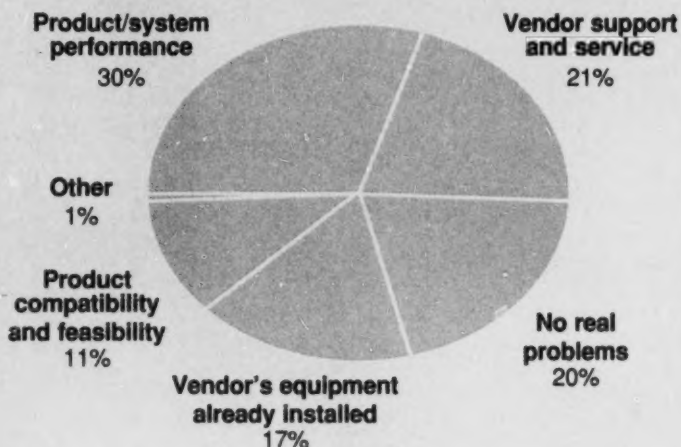
Present cost accounting methods were developed when industry was labor-intensive and direct labor was the dominant component of product cost. Today, most electronics companies experience direct labor costs that are 5% to 15% of product costs. The costs of materials, overhead and indirect labor are more important now. It is the latter two nondirect costs that managers have difficulty identifying and quantifying — this cripples ROI analysis of automation. (Continued)

Who prompted electronics companies to automate the design process?

	Most influential	Second most influential	Third most influential	Total respondents marking each category
Engineering department request	28.9%	5.7%	3.4%	38%
Manufacturing department request	9.2%	3.8%	—	13%
President/CEO directive	3.9%	8.7%	2.4%	15%
Part of CIM plan	3.8%	2.5%	2.7%	9%
Other	3.2%	0.8%	—	4%
Competition using it	3.1%	5.0%	5.9%	14%
Customer request	0.7%	0.4%	0.9%	2%
Marketing department request	—	3.2%	1.8%	5%

COMPUTER INTEGRATED MANUFACTURING

Why workstation users would buy again from their current vendors



To provide the correct data for ROI analysis, companies must first diagram the flow of work and data in any part of the organization affected by the proposed automation ROI system. If this diagram is not accurate, the foundation for the cost and benefit analysis begins to crumble.

Once the work and data flow are understood, cost-driving sources are identified. One cost driver is when engineering design errors are discovered after the design is released to manufacturing.

A design error would trigger the performance of a number of tasks: inspecting or testing parts; preparing failure reports; requesting an engineering change; modifying the design, the bill of materials and routings; changing tooling; adjusting purchasing speci-

fications and so on. Each activity would be identified, assigned to a cost center, and its costs quantified.

This is the only way accurate cost and benefit information can be included in the ROI analysis of the proposed workstation. The alternative is an analysis which focuses on direct labor costs and benefits and ignores nondirect costs in an industry where overhead and indirect labor costs are key.

Vendor performance

Our survey companies' current vendors of automation equipment would be selected again for additional purchases by 86% of the respondents. They said their chief reasons for staying with the current vendors are: product performance, vendor service and support, and the lack of significant problems with the equipment in place. The fourth most frequent reason given is that the vendors' equipment was already in place, demonstrating the importance of an installed base to vendors.

The three biggest vendors that our respondents used were Apollo, DEC and IBM. In the companies with less than \$250 million in revenue, IBM took the lead. However, market leadership switched to DEC with companies having sales greater than \$500 million. And, in the midrange, Apollo became a major player, ultimately matching or beating IBM's market share.

The good news for vendors is that the biggest problem electronics companies are having in automating the design and engineering function is lack of funding, not lack of vendor support. This suggests that, as the electronics industry works its way out of the slump of 1985 and 1986, sales for workstations should rise significantly. Vendors should also take note that the second largest problem cited by users — that equipment did not perform as promised — suggests room for improvement. □

How did electronics companies rate their biggest problems so far in automating the design process?

	Biggest problem	Second biggest problem	Third biggest problem	Total respondents marking each category
Lack of funding	12.6%	4.0%	3.4%	20%
Equipment did not perform as promised	9.7%	4.3%	3.0%	17%
Employee retraining	9.0%	7.5%	5.5%	22%
How to measure designer's performance	5.6%	2.9%	3.5%	12%
Other	4.4%	1.0%	0.6%	6%
No problems	2.8%	0.4%	0.8%	4%
Manager training	2.2%	4.7%	3.1%	10%
Lack of vendor support	1.5%	5.1%	2.4%	9%

Design Automation Survey

Has your company invested in automating the product design process?

Yes	75%
No	24%
No response	1%



Three quarters of the companies responding have invested in automating the design process.

If yes, check categories in which your company has invested. If no, check the categories in which you anticipate investment:

Schematic capture	23%
Circuit board layout/artwork	18%
Simulation	16%
Circuit design/logic	15%
Layout/timing verification	11%
Electrical design rules	9%
Generation of test patterns	6%
Other	2%



Much of the investment has gone into schematic capture and circuit board layout rather than the more engineering-intensive activities of simulation, verification and test.

How much has your company invested in automating each part of the design process, and how much does your company anticipate to invest in calendar 1987?

	\$1,000 – \$5,999	\$6,000 – \$50,000	\$50,001 – \$500,000	\$500,001 – \$1 million	Over \$1 million
Current investment					
Schematic capture	27%	40%	24%	2%	7%
Circuit board layout/artwork	21%	27%	32%	7%	13%
Simulation	21%	29%	35%	6%	9%
Circuit design/logic	23%	27%	37%	4%	9%
Layout/timing verification	18%	25%	41%	6%	10%
Electrical design rules	18%	28%	38%	6%	10%
Generation of test patterns	21%	33%	15%	15%	16%
Other	16%	32%	26%	16%	10%
Expected 1987 investment					
Schematic capture	34%	45%	18%	0%	3%
Circuit board layout/artwork	31%	33%	29%	3%	4%
Simulation	23%	53%	18%	1%	5%
Circuit design/logic	23%	42%	27%	3%	5%
Layout/timing verification	33%	40%	19%	2%	6%
Electrical design rules	24%	31%	34%	3%	8%
Generation of test patterns	24%	36%	24%	8%	8%
Other	25%	40%	40%	0%	0%

As system cost declines, investment activity is projected to pick up dramatically at the low end while leveling off at the high end.

COMPUTER INTEGRATED MANUFACTURING

What was the most important factor which prompted your company to automate the design process?

Engineering dept. request	38%
President/CEO directive	15%
Competition using it	14%
Manufacturing dept. request	13%
Part of CIM plan	9%
Marketing dept. request	5%
Other	4%
Customer request	2%

The initiative to automate is still coming from the engineering department. Upper level management remains the second most important influence in starting the automation process.

What was the most important factor in justifying these investments?

Faster time to market	30%
Improved manufacturing quality	25%
Traditional ROI methods	21%
Shortage of skilled designers	12%
Can't design product without it	9%
Other	3%

The need to speed the new product development process outpaces all other reasons for justifying the design automation investment.

Who approved the decision to automate?

President/CEO	51%
Chief engineer	25%
Operations manager	12%
Chief financial officer	8%
Other	4%

The boss still controls the purse strings. Presidents, chief executives and chief engineers are the gatekeepers to design systems spending.

What has been the biggest problem so far in automating the design process?

Employee retraining	22%
Lack of funding	20%
Equipment did not perform as promised	17%
How to measure designer's performance	12%
Manager retraining	10%
Lack of vendor support	9%
Other	6%
No problems	4%

Employee retraining has proven to be more of a problem in automating the design process than access to funds.

Do you think your company is more, or less, automated than your competition?

More	23%
Same	37%
Less	32%
No opinion	8%

On the whole, respondents did not feel they were clearly in the lead or significantly behind their competition in the race to automate.

Approximately how many engineers and designers does your company have?

The average was 205 engineers and designers.

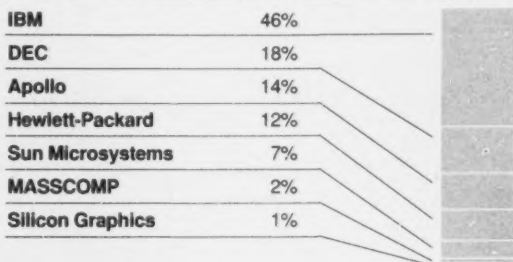
Approximately how many design/engineering workstations does your company have?

The average was 54 workstations.

On average, companies have a 1:4 ratio of workstations to engineers and designers.

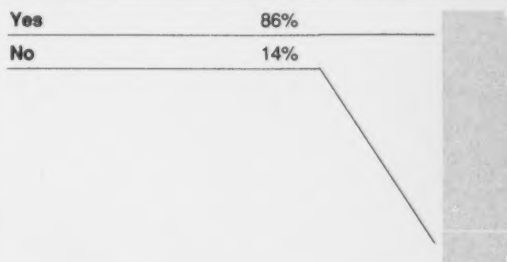
COMPUTER INTEGRATED MANUFACTURING

What vendors make the workstations that you use? (Check all which apply.)



IBM remains the leading workstation, with DEC and Apollo in the second and third positions.

Would you buy again from the same vendors?



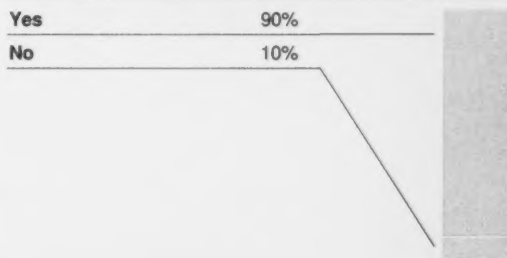
Most respondents would go back to the same vendor they had dealt with before.

What have been your results in automating the design process?

	Yes	No	NA
Met ROI expectations	52%	29%	19%
Improved productivity	78%	12%	10%
Achieved faster time to market	68%	15%	17%
Improved manufacturing quality	71%	16%	13%
Other	52%	44%	4%

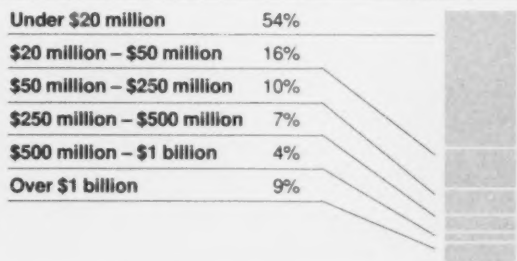
The respondents have been pleased so far with the results of their automation efforts.

If you had to do it over, do you believe your company would choose to automate the design process?



An overwhelming number of respondents are convinced that automation was a wise move.

Your company's annual revenue is approximately:



The respondents came from a broad range of small, medium and large size companies.

Your company deals in which of the following? (Check all which apply.)

Industrial-based computer systems	13%
Components	11%
Communications	10%
Microcomputers	10%
Capital equipment	9%
Semiconductors	8%
Military	7%
Minicomputers	7%
Peripherals	7%
Office equipment	5%
Mainframe computers	2%
Distribution	1%
Other	10%

The respondents were from a wide spectrum of computer and component companies in the electronics industry.

Defense drives Israel's electronics industry

With government support, Israel is emerging as a major high-tech arms dealer on the world market

It is now 20 years since Israel annihilated the air forces of Egypt and its Arab neighbors at the start of the Six Day War. By the end of that day — June 5, 1967 — the Israelis' French-built Mirage III fighter-bombers knocked out 374 enemy planes for the loss of only 19 of their own.

But, General Charles de Gaulle, France's President, was bent on winning Arab allies. Just as the Israelis were celebrating their victory, de Gaulle banned future deliveries of Mirages to Israel. "De Gaulle's embargo taught us a tough lesson," recalls General Dan Tolkowsky, a former commander in chief of the Israeli air force and now the country's leading venture capitalist. "We learned we could not afford to depend on foreign technology. And that's how Israel was driven to develop its own high-tech industries."

Today Israel makes many of its own warplanes and much of its avionics. The latest jet fighter, the Lavi, has been hailed by U.S. experts as one of the most advanced — but also the costliest — in the world. Israel has certainly not slammed the door on foreign suppliers. "But what matters is that we have mastered state-of-the-

art technologies," says Uzia Galil, president of Elron Electronics Industries Ltd., a diversified electronics holding company. "U.S. and European high-tech companies today prefer to sell us whatever we need because they know we can always go ahead and make it ourselves."

As a result, Israel today boasts a number of world leaders in electronics such as Elbit Computers Ltd. in defense systems, Elscint Ltd. in diagnos-

Israel today boasts a number of world leaders in electronics

tic medical imaging, Fibronics Ltd. in fiber-optic communications, Laser Industries Ltd. in laser surgery, Optrotech Ltd. and Orbot Systems Ltd. in vision systems for inspecting printed circuit boards (PCBs) and Scitex Corporation Ltd. in image processing.

For all these companies the United States is the major sales outlet. And many of the managers and engineers who work in them are often graduates of both Israeli universities, such as Technion, and of the Massachusetts Institute of Technology or Stanford. "There's a genuine cross-culture between U.S. and Israeli electronics," remarks Elron's Galil.

Spurred by its harsh experience when France withheld warplanes during the Six Day War, Israel has strongly focused its electronics industry on meeting the country's defense needs. These requirements often match those of the United States.

Elbit, the defense systems manufacturer, now earns one-third of its revenue in the United States, and half its sales backlog lies there. It has supplied weapons delivery and navigation systems for the General Dynamics F-16 warplane and is now upgrading the avionics of the McDonnell Douglas F-4 Phantom aircraft. The Israeli company's digital tank fire control system has been adapted for the American M-48 and M-46 and, in a simplified version, for the M-41,

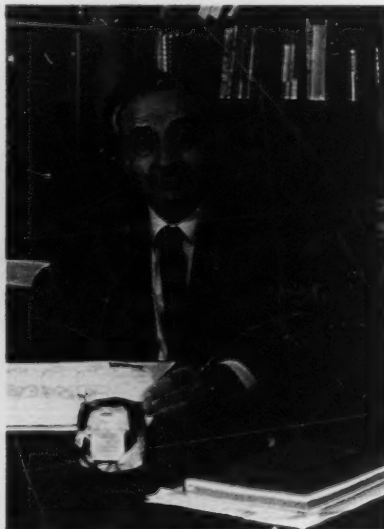
M-47 and Sherman tanks.

Aharon Amit, Elbit's vice-president of marketing, says: "Now that the Israeli government has cut back its spending on defense, overseas sales are becoming even more important than ever."

Israel Aircraft Industries Ltd. (IAI) is also a major supplier of high-tech products to both the Israeli and U.S. armed forces. These include the Mini-Remotely Piloted Vehicles (MIRPV), developed jointly by IAI's subsidiary Tamam Precision Instruments with Tadiran Printed Circuits Ltd. The Mastiff MIRPVs have been awarded contracts by the U.S. Army and Navy following the successful use of this drone by the Israeli armed forces in Lebanon.

MBT Weapons Systems, another IAI offshoot which is famous for the Gabriel missile family, works closely with U.S. military contractors. Noam Zafir, international marketing manager at MBT, says: "The Americans are particularly interested in our work because most of our engineers serve regularly in Israeli military reserve units. That means we get excellent input about how our products perform under battle conditions."

State funded research and development (R&D) play key roles in encouraging new electronics ventures in Israel. "In fact, we are the real venture capitalists here," says Yigal Erlich, chief scientist and head of industrial research and development at the Ministry of Industry and Trade. State aid, which will total \$80 million for the current fiscal year, has launched a



ELRON's GALIL worries about the brain drain to the U.S.



OPTROTECH's BARAK plans to expand into vision-based products

PLANT SITES

host of companies, both large and small.

These include foreign ventures in Israel. "The yardstick is whether the company manufactures in Israel," Erlich explains. "And the emphasis is on exports. Until now, each dollar we've invested in R&D has returned between eight and 10 times as much in foreign sales."

Erlich also earmarks cash for salaries out of his budget. "On a case by case basis, we are ready to examine payments for the salaries of U.S. engineers and other staff working on R&D projects in Israel," he says.

Cooperation between the two countries to support projects with strong commercial potential has been steadily consolidated since the creation in 1978 of the Israel-U.S. Binational Industrial Research and Development Foundation (BIRD-F). The group, which is financed by both governments, matches funds with each partner in the joint development of any innovative technical product or process.

Erlich of the Ministry of Industry and Trade would like to see more involvement by Israeli businessmen and venture capital in creating new high-tech companies. "I personally favor better tax incentives, such as lower capital gains taxes for startups," he says. "But other government departments do not agree."

Optrotech and Orbot

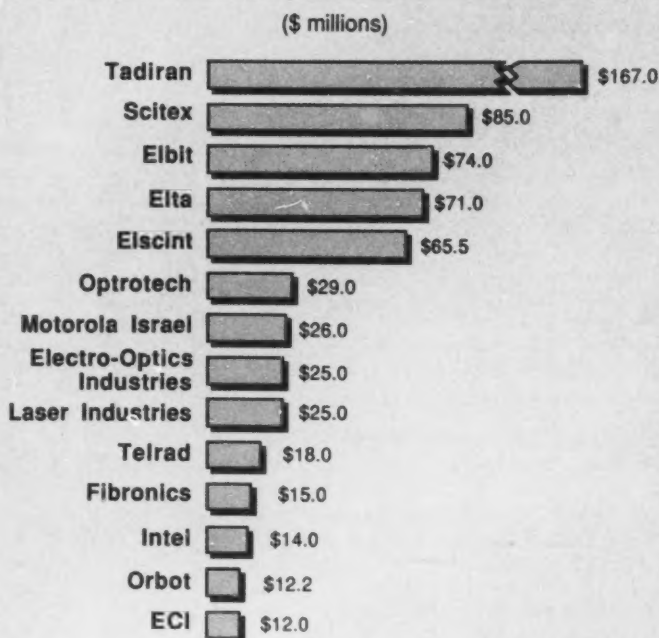
Erlich singles out Optrotech, a world leader in manufacturing equipment for the optical inspection of printed circuit boards, as a company "where our money has been well spent."

"This young company is successful not only in Israeli terms, but in American terms as well," says Uzia Galil of Elron which holds 43% of Optrotech's shares.

Optrotech is confident in its future, in spite of the slump in the electronic components industry and increased competition, particularly from Orbot, its rival and fellow Israeli company. "We're going to spread out into more vision-based products," says Optrotech's president Shlomo Barak. "But, for the moment, their nature is confidential."

Orbot, which arrived in the PCB optical inspection market after Optrotech, is giving it a run for its money. The two companies now share 90% of world sales in their sector. And, like Optrotech's Barak, Hanan Gilutz, director of marketing and sales at Orbot,

Sales of leading Israeli electronic manufacturers in 1986



Source: Israeli Ministry of Industry & Trade

says: "We, too, are diversifying into new products."

With Digital Equipment Corp., Intel Corp., Motorola Inc. and National Semiconductor Corp. designing or manufacturing chips there, the integrated circuit sector is becoming increasingly important to Israel's electronics industry. Tadiran, the country's biggest electronics group, recently completed a \$20 million plant at Kiriat Malachi to assemble printed circuit boards.

Igal Carmi, marketing manager of Tadiran, says the United States is buying 25% of its boards. Fifty percent go into Tadiran products and 25% are sold to other Israeli electronics manufacturers. "Even in a depressed U.S. market we can do well with a tiny share," Carmi adds.

Scitex Corporation Ltd. is an imaginative Israeli company that has found a profitable niche in interactive turn-key graphics systems. These products automate labor-intensive imaging processes in printing, publishing, printed circuit board manufacturing, energy exploration and cartography throughout the world. The bulk of Scitex's sales — more than 80% — is derived from so-called "prepress" work, the preparative procedures for printing magazines and newspapers. In 1985 Scitex earned 55% of its revenue in the U.S., 35% in Europe and

the remaining 10% in Japan and other countries.

Scitex is building up substantial business in the U.S. press industry with its transportable color scanner, Satlight, which is replacing couriers and express mail services for color photographs. Rafi Bronstein, a Scitex marketing manager, says: "Not many Americans have heard about Satlight. But millions of them have seen at least 200 photos of the last Democratic National Convention and the Olympic Games which were transmitted by our scanner system."

Recessionary winds

However, with a wide range of innovative and successful companies, Israel's electronics industry is not sheltered from the cold blast of recession blowing through the industry at large. Profits for most of its high-tech companies took a beating last year. And they are worried whether 1987 will restore their fortunes.

The Israelis are also contending with other problems. Attractive jobs and salaries in the United States and Europe are competing for their best talent. Heavy taxation is triggering a brain drain whose importance is rated from negligible to serious by the men who manage Israel's electronics industry.

Dov Frohman, inventor of the eras-

JUNE IN

Electronic Business

June 1

- Computers
- Distribution
- Production/Process Equipment
- Plant Sites & Facilities
- Semiconductors
- Military Electronics

Advertising Deadline:
May 4, 1987

June 15

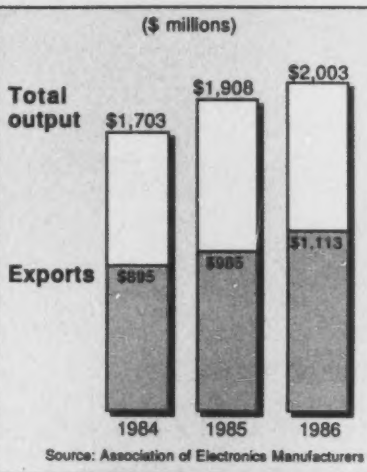
- CAD/CAM/CAE
- Semiconductors
- Automatic Test Equipment
- Plant Sites & Facilities
- Components
- Communications
- Computer Peripherals

Advertising Deadline:
May 18, 1987

A CAHNER'S PUBLICATION
275 WASHINGTON STREET
NEWTON, MA 02158
(617) 984-3030

PLANT SITES

Exports account for more than half of Israel's electronics production



able-programmable read-only memory (EPROM) and now general manager of Intel's operations in Israel says: "I doubt there's really a major exodus." He adds: "On the contrary, the atmosphere of working in Israel is so challenging that it attracts people from the U.S. and Europe and encourages Israelis to stay."

Frohman says he prefers to hire Israelis who are committed to their own country rather than those who have gone abroad to study and gain experience. "Those people tend to become prima donnas. Nine out of 10 in this category want to be plant managers. But they usually don't have the qualities needed to run an Israeli company."

However, at Elscint, a medical imaging company that ranks among the world's leaders, Natan Ron, the corporate secretary, disagrees. Ron, who, like Frohman, came to Israel from the United States — he formerly managed a law office in Washington, D.C. — says: "Israel's electronics industry still needs to attract able young people from the U.S. Israeli universities cannot cope with the demand for talent."

He is also convinced that the Israelis have a lot to learn from the United States. "In Israel, everybody wants to be king and take a chance. But what we need are men and women who are fed on coolness, discipline and reasoned judgment. The U.S. can help us by sending more of these people to teach our own bright youngsters about strategic planning. In Israel we are strong on hutzpah and innovation. But we are not well organized."

Ron argues that young Israelis who go to the United States for schooling and professional experience become major assets to their country's electronics industry when they return home. "Most of our production heads here at Elscint are ex-paratroopers," he remarks. "Taking leave of business contacts with a 'Have a nice day' is alien to their culture. So exposure to the U.S. environment helps to rub off some of the edges."

He stresses that, during their three years of compulsory military service, young Israelis become immersed in electronics. This experience makes them keen and able to take jobs in the high technology sector when they come out into the working world, Ron adds.

Elron's Galil says: "It's good for Israelis to go abroad to study and work. But the problem is to ensure they come back. I'm not sure we have got the right balance in and out. We have to motivate these people to ensure they come back. And not 15 years later, but after five."

But the heavy hand of government bureaucracy and high taxation are certainly discouraging both Israeli and U.S. engineers and managers from making careers in the country's electronics industry. Israel's income tax leaves only \$10,000 out of an engineer's \$30,000 annual salary.

"We have a very high rate of new regulations covering taxation and foreign exchange which can act as a deterrent," says Frohman. He quotes his own embarrassment at having to let a Japanese colleague foot a hotel bill in Tokyo because the Israeli government would not let him take enough foreign currency for his trip.

Frohman also emphasizes the need for Israeli managers to learn manufacturing disciplines. "They need to become competitive while producing in automated plants. This is something which they are not all that good at," says the Intel veteran. He adds: "Not enough focus has been put on manufacturing discipline in Israel until now."

Elron's Galil is concerned about what he and other Israeli businessmen regard as excessive state intervention in the country's industry. "If the state sells the enterprises that it controls, relaxes taxation and foreign exchange restrictions, there will be a boom in Israel," he says. "But the present situation is handicapping motivation — both for investors and the people who work in our high-tech companies."

JACK GEE

QUARTERLY SCORECARD

Financial results of leading U.S. electronics companies

Industry segment averages

Percentage change from 4th quarter of 1985 to 4th quarter of 1986

Revenue

Components	+21.2%
Semiconductors	+12.7%
Computers	+7.4%
Capital equipment	+3.3%
Communications	+9.3%
Distributors	+12.6%
Office equipment	+9.7%
Diversified	+10.2%
Military	+17.9%

Profits

Components	-38.7%
Semiconductors	+104.9%
Computer	-47.6%
Capital equipment	NM
Communications	+153.5%
Distributors	NM
Office equipment	-15.5%
Diversified	+78.0%
Military	+8.6%

Components

(Other than semiconductors)

	Revenue 4th quarter 1986 (\$ millions)	Change from 1985	Profits 4th quarter 1986 (\$ millions)	Change from 1985	Revenue year-to-date 1986 (\$ millions)	Change from 1985	Profits year-to-date 1986 (\$ millions)	Change from 1985	Quarter ended
AMP	\$506.0	+21.9%	\$46.0	+110.1%	\$1,933.0	+18.1%	\$164.0	+51.9%	Dec. 31
AVX	50.5	+18.0%	1.0	-81.4%	195.4	+9.3%	3.1	-74.8%	Dec. 31
Augat	64.5	+0.1%	15.7	NM	260.4	+2.1%	-8.7	NM	Dec. 31
CTS	65.5	+20.9%	-21.5	NM	245.5	-6.1%	-23.8	NM	Dec. 28
Molex	91.8	+39.9%	9.5	+31.9%	349.4	+36.8%	38.9	+37.7%	Dec. 31
Segment composite	\$778.3	+21.2%	\$19.3	-38.7%	\$2,983.7	+15.3%	\$173.4	+20.1%	

Semiconductors

Advanced Micro Devices	\$150.2	+4.3%	-\$17.7	NM	\$615.2	-1.4%	-\$103.9	NM	Dec. 28
Intel	355.6	+11.9%	-16.4	NM	1,265.0	-7.3%	-183.3	NM	Dec. 31
International Rectifier	38.6	+10.7%	-1.9	NM	151.7	+7.5%	-6.6	NM	Dec. 31
LSI Logic	54.5	+31.5%	1.7	-54.9%	194.3	+38.8%	3.9	-61.9%	Dec. 31
Texas Instruments	1340.0	+10.7%	26.6	NM	4,970.0	+1.0%	39.9	NM	Dec. 31
Western Digital	109.8	+56.9%	10.5	+125.6%	346.1	+48.2%	32.8	NM	Dec. 27
Segment composite	\$2,048.8	+12.7%	\$2.8	-104.9%	\$7,542.3	+1.6%	-\$217.2	NM	

Computers and peripherals

Amdahl	\$336.8	+30.9%	\$27.1	+188.0%	\$966.3	+12.1%	\$39.3	+61.1%	Dec. 26
Apollo	120.9	+71.0%	5.3	+623.6%	391.7	+32.5%	9.3	NM	Jan. 3
Apple	662.3	+24.0%	58.5	+2.7%	2,030.3	+15.8%	155.5	+115.8%	Dec. 26
COMPAQ	186.9	+19.6%	16.2	+62.3%	625.2	+24.1%	42.9	+61.3%	Dec. 31
Conrac	43.6	+16.3%	2.1	-5.2%	153.9	+2.4%	7.8	+8.4%	Dec. 31
Control Data	903.6	-7.9%	-17.3	NM	3,346.7	-9.0%	-102.3	NM	Dec. 31
Convergent	77.4	-34.9%	-4.5	NM	305.8	-33.4%	-32.8	NM	Dec. 31
Cray Research	138.2	+63.1%	23.3	+93.8%	596.7	+57.0%	124.8	+65.1%	Dec. 31
Data General	313.3	+6.7%	3.3	+200.0%	1,287.5	+7.4%	7.9	+237.4%	Dec. 27
DEC	2,271.8	+22.0%	270.0	+98.3%	8,414.3	+19.7%	861.6	+115.1%	Dec. 27
Honeywell	1,617.1	+7.9%	-97.5	NM	5,378.2	+7.7%	12.9	-94.1%	Dec. 31
IBM	16,945.0	-1.2%	1,390.0	-48.2%	51,250.0	+2.4%	4,789.0	-26.9%	Dec. 31
Mentor Graphics	49.3	+34.6%	3.9	+137.5%	173.5	+26.9%	11.0	+37.7%	Dec. 31
Micropolis	51.8	+43.1%	5.1	+128.5%	213.1	+124.6%	18.3	+557.2%	Dec. 26
Miniscribe	52.9	+48.5%	6.4	+157.7%	184.9	+62.2%	22.7	+35.4%	Dec. 31
Prime	230.9	+10.0%	14.2	-18.9%	860.2	+11.8%	46.9	-18.8%	Dec. 31
Sun Microsystems	115.3	+173.3%	8.5	+405.6%	341.1	+131.9%	24.5	+204.9%	Dec. 26
Tandem	238.0	+40.0%	27.1	+132.6%	835.8	+31.7%	79.2	+147.6%	Dec. 31
Telex	212.5	+20.4%	18.3	+3.0%	817.0	+19.6%	72.7	+8.4%	Dec. 31
Unisys	2,535.8	+71.3%	-188.5	NM	7,432.4	+47.5%	-43.4	NM	Dec. 31
Segment composite	\$27,103.3	+7.4%	\$1,571.5	-47.6%	\$85,604.7	+8.4%	\$6,147.9	-18.5%	

NM = not meaningful

Continued

QUARTERLY SCORECARD

Financial results of leading U.S. electronics companies

Capital equipment	Revenue 4th quarter 1986 (\$ millions)	Change from 1985	Profits 4th quarter 1986 (\$ millions)	Change from 1985	Revenue year-to-date 1986 (\$ millions)	Change from 1985	Profits year-to-date 1986 (\$ millions)	Change from 1985	Quarter ended
Computervision	\$136.5	+16.5%	\$3.5	NM	\$494.7	+12.2%	-\$5.8	NM	Dec. 31
Fluke	51.2	-1.0%	2.6	-18.4%	208.5	-2.9%	11.6	-20.3%	Dec. 31
GenRad	61.5	+24.0%	-1.5	NM	204.3	-6.4%	-29.9	NM	Dec. 31
Spectra-Physics	48.7	-2.6%	0.1	+25.9%	208.8	+5.0%	0.9	NM	Dec. 31
Tektronix	320.2	-0.7%	17.4	+36.2%	1,352.4	-4.7%	55.1	-21.4%	Nov. 15
Teradyne	73.6	-0.4%	0.1	-77.5%	306.1	-9.0%	0.2	-98.9%	Dec. 31
Varian	214.9	+1.1%	2.4	+42.3%	908.3	-4.3%	-14.2	NM	Jan. 2
Segment composite	\$906.5	+3.3%	\$24.6	NM	\$3,683.1	-2.5%	\$17.9	NM	

Communications

Andrew	\$48.7	+0.6%	\$2.3	+0.7%	\$198.0	-4.7%	\$9.5	-21.9%	Dec. 31
Avantek	70.8	+16.9%	5.5	-25.4%	208.2	+23.7%	16.1	-12.1%	Dec. 31
Aydin	34.4	-2.4%	1.6	+67.9%	136.8	+2.8%	7.0	+83.0%	Dec. 31
DSC Communications	74.5	-3.3%	2.4	NM	304.0	+5.7%	11.0	NM	Dec. 31
Dynatech	76.0	+13.0%	6.4	+21.0%	281.3	+9.6%	23.5	+2.5%	Dec. 31
General DataComm	52.3	+27.3%	1.4	-5.0%	189.5	+5.2%	3.9	-55.9%	Dec. 31
Micom Systems	50.5	+2.8%	3.5	-16.6%	191.6	-1.4%	9.5	-34.9%	Dec. 31
Northern Telecom	1,310.0	+10.1%	132.2	+46.2%	4,380.0	+2.8%	313.2	+4.7%	Dec. 31
Paradyne	63.8	+5.9%	-26.3	NM	261.1	+3.4%	-37.6	NM	Dec. 31
Segment composite	\$1,780.9	+9.3%	\$129.0	+153.5%	\$6,150.4	+3.5%	\$356.1	+20.2%	

Distributors

Arrow Electronics	\$132.5	+10.7%	-\$6.8	NM	\$529.6	-0.8%	-\$28.7	NM	Dec. 31
Avnet	375.9	+10.7%	4.6	-41.0%	1,476.5	+6.6%	18.6	-43.4%	Dec. 31
Marshall Industries	66.7	+18.4%	0.8	+438.6%	269.2	+16.2%	4.5	+205.7%	Nov. 30
Pioneer-Standard	54.3	+4.5%	0.3	NM	214.2	+3.4%	-0.4	NM	Dec. 31
Wyle	81.1	+27.9%	1.1	+90.3%	307.0	+17.7%	4.3	+184.5%	Jan. 31
Segment composite	\$710.5	+12.6%	\$0.0	NM	\$2,796.5	+6.8%	-\$1.7	NM	

Office equipment

Diebold	\$109.9	-1.2%	\$10.0	-4.0%	\$413.7	+0.7%	\$34.9	+14.8%	Dec. 31
NBI	69.8	-2.0%	-4.0	NM	283.1	+8.6%	-10.4	NM	Dec. 31
NCR	1,575.1	+12.1%	134.1	+0.6%	4,881.6	+13.1%	336.5	+6.8%	Dec. 31
Pitney Bowes	563.4	+10.2%	53.9	+10.6%	1,986.7	+9.4%	166.1	+17.2%	Dec. 31
Savin	82.5	-10.8%	-0.9	NM	362.7	-8.7%	-11.1	NM	Dec. 31
Wang	668.9	-1.6%	-78.6	NM	2,668.9	+9.9%	-86.4	NM	Dec. 31
Xerox	3,700.0	+12.1%	138.0	+21.1%	12,900.0	+10.3%	488.0	+28.1%	Dec. 31
Segment composite	\$6,769.6	+9.7%	\$252.5	-15.5%	\$23,496.6	+10.2%	\$917.6	+18.1%	

Diversified

General Instrument	\$262.0	+31.1%	\$2.0	NM	\$871.7	+8.5%	\$15.4	NM	Nov. 30
Gould	227.4	-2.5%	5.5	-66.9%	908.8	-1.6%	34.6	NM	Dec. 31
Harris	534.3	-5.6%	20.1	+38.7%	2,106.4	-9.0%	68.6	+13.0%	Dec. 26
Motorola	1,619.0	+11.8%	63.0	+43.2%	5,888.0	+8.2%	194.0	+169.4%	Dec. 31
N.A. Philips	1,356.0	+2.3%	60.3	+125.8%	4,531.6	+3.1%	81.2	-0.4%	Dec. 31
Tandy	1,196.0	+19.5%	103.8	+19.3%	3,322.8	+16.2%	225.9	+12.0%	Dec. 31
Zenith	597.1	+23.4%	0.4	-88.9%	1,892.1	+16.5%	-10.0	NM	Dec. 31
Segment composite	\$5,791.9	+10.2%	\$255.1	+78.0%	\$19,521.5	+6.3%	\$609.7	+184.0%	

Military

E-Systems	\$301.0	+24.8%	\$14.9	-2.1%	\$1,135.1	+22.5%	\$61.6	+3.5%	Dec. 31
ElectroSpace Systems	46.4	+25.6%	2.6	-26.1%	179.9	+35.0%	10.0	-20.3%	Jan. 2
Logicon	49.1	-2.6%	2.2	-9.5%	204.5	+7.7%	9.3	-3.7%	Dec. 31
Loral	165.2	+1.0%	13.3	+3.6%	683.6	+14.1%	56.6	+16.3%	Dec. 31
Raytheon	2,041.2	+19.2%	99.6	+0.9%	7,308.0	+14.0%	393.2	+4.6%	Dec. 31
Tracor	171.3	+19.3%	6.7	NM	632.1	+15.7%	18.8	+40.9%	Dec. 31
Watkins-Johnson	64.5	+7.0%	3.6	-41.6%	255.4	+9.8%	17.2	-6.5%	Dec. 31
Segment composite	\$2,838.8	+17.9%	\$142.9	+8.6%	\$10,398.6	+15.1%	\$566.8	+5.3%	

NM = not meaningful